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AN ICE SHIP AT MACKINAC, MICHIGAN.

FOR five years back the railway lines reaching the Straits of Mackinac have been endeavoring to establish a winter crossing at that point, to connect the lower peninsula of Michigan with the upper, or Lake Superior district. In summer the crossing is readily made by steamers, but during the winter months the ice forms a barrier very difficult to overcome. Horses and sleighs were for some time used, but were unsatisfactory, especially when heavy freight had to be transferred.

The first attempt at crossing through the ice by steamer was made by the Algomah, a screw steamer, built especially for that service. She had a spoon-shaped bow which crushed the ice beneath her, and heavy machinery to force her through it, but proved a failure, owing to her inability to force a passage through the windrows of ice formed by autumn gales. These windrows, which are formed by broken ice, often extended for several miles along the shore, where the masses of ice ground in about twenty-five feet of water, and extend ten to fifteen feet above the surface, looking like a miniature range of mountains. It was found that the Algomah did her best work in broken ice by going astern, her propeller serving in a measure to clear her path. The idea gained by this was reduced to practicability by Frank E. Kirby, of the Detroit Dry Dock Company, and the result is the steamer St. Ignace.

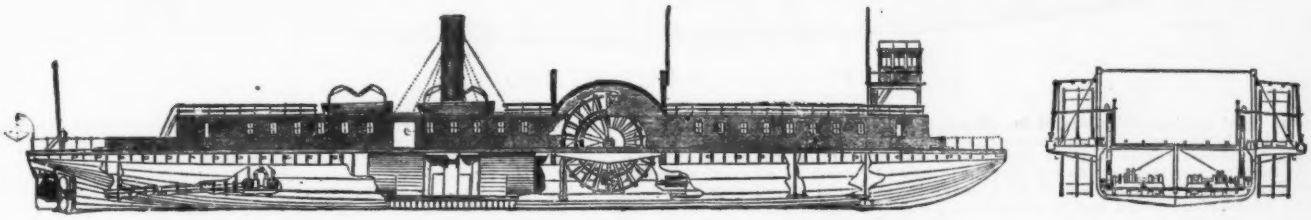
The St. Ignace is a double-ended steamer, having a heavy propeller, driven by an independent engine, at the bow, in addition to the usual one astern. She was completed late in March, and immediately left for Mackinac. On Lake Huron she encountered 250 miles of ice, averaging about 2 ft. in thickness, but in places piled up to a depth of 10 ft. This she passed through without any trouble, and was welcomed on arriving at her destination by almost the entire population, who came out on the ice to meet her in sleighs. Her first hard task consisted in reaching her wharf at Mackinac City. The ice had piled up and frozen solid for a distance of 1,000 ft. out from the end of the wharf. The outer face of this mass was 20 ft. deep. It rested on the bottom of the harbor all the way out, and extended 5 ft. to 6 ft. above the water level. Her bow was shoved against this ice, and both propellers set in motion. The forward propeller burrowed into the ice, loosening the pieces and sending them aft, where they came under the influence of the suction of the stern propeller, and were forced astern. After one hour's steady work, the St. Ignace had torn a channel for herself, and reached the wharf. Her first cargo consisted of eight locomotives, each weighing sixty-one tons, which she carried safely across the straits. Her ordinary cargo is twelve freight cars, and she makes the eight miles between Mackinac City and St. Ignace through from two to three feet of ice in one hour. Our engraving is from a drawing by Mr. James Barr, of the *Detroit Free Press.—The Graphic.*

STEEL FERRY STEAMER FOR THE MICHIGAN CENTRAL.

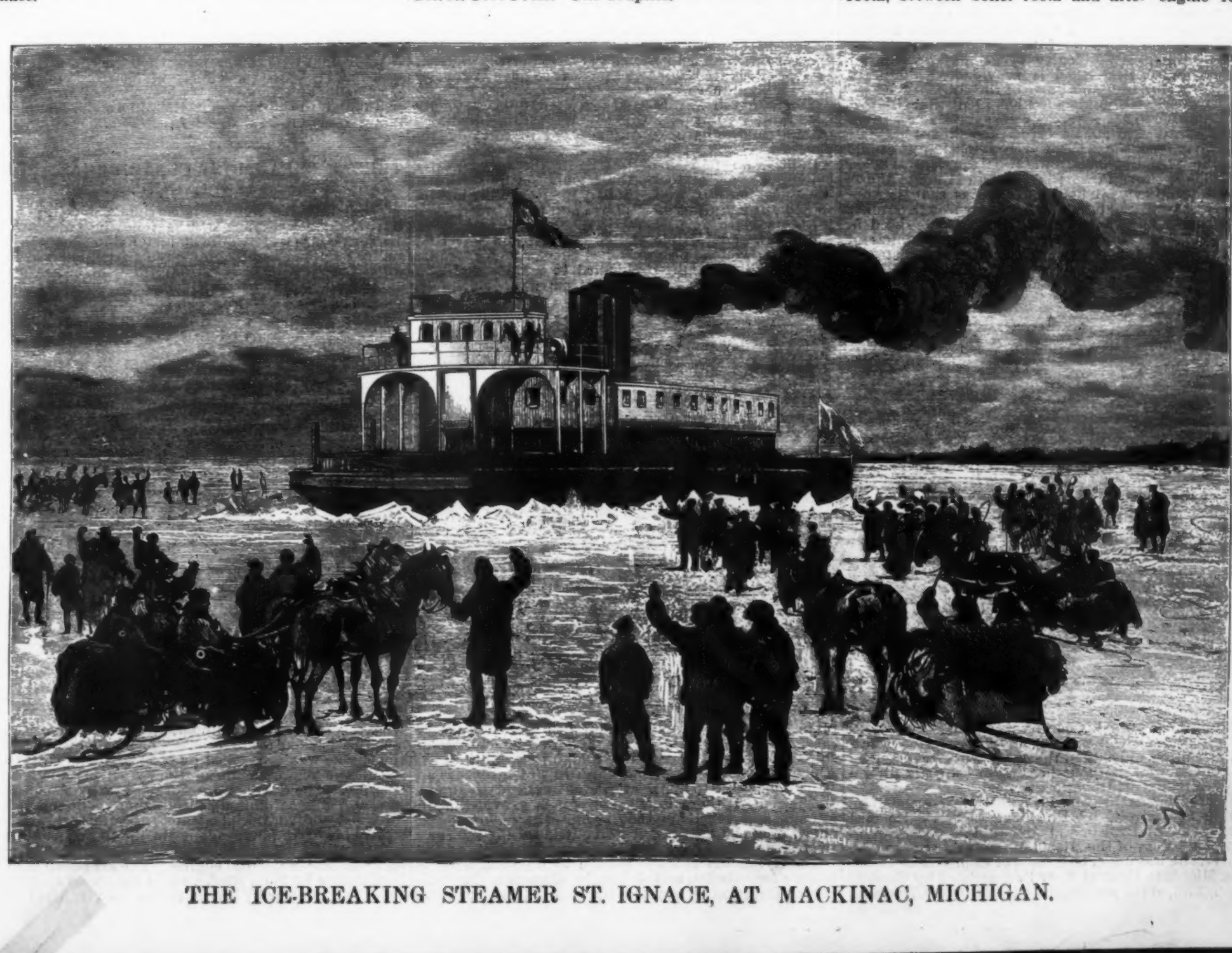
THE Cleveland Ship Building Company, of Cleveland, Ohio, has recently completed a large steel ferry steamer for the Michigan Central Railroad, to ply between Detroit, Mich., and Windsor, Ont. The vessel has some peculiarities of design and is one of the heaviest steel vessels ever built on the lakes, if not the heaviest. The cuts herewith give some idea of the general design. The vessel is 280 ft. long over all, 45 ft. 6 in. breadth of hull, 74 ft. 6 in. across the guards, and 17 ft. 3 in. deep. She is built entirely of steel, except the cabins for crew, which are located on the guards, leaving a clear deck which will take three tracks, each track accommodating seven of the longest freight cars. When light with coal on board, she will draw 9 ft. forward and 10 ft. aft; with 21 loaded cars her draught will be about 11 ft. forward, 12 ft. aft. The pilot house is located on a bridge 19 ft. above the main deck and near the bow.

Her bow is of the most approved form for breaking through the heaviest ice; having a vertical section like a sled runner, and the regular scantlings of the ship are increased in weight and re-enforced with extra keelsons and bulkheads to give the necessary strength.

The hull is covered with a steel deck; has collision bulkhead forward, and bulkheads between store room and engine room, between engine room and boiler room, between boiler room and after engine room,



FERRY STEAMER TRANSFER, MICHIGAN CENTRAL RAILROAD.



THE ICE-BREAKING STEAMER ST. IGNACE, AT MACKINAC, MICHIGAN.

and one at inboard end of stern pipe. Between the bulkheads, belt frames occur on every sixth frame, except for 60 feet aft of the paddle wheels, where they occur on every other frame, experience having shown that unusual strength is necessary in this place.

The vessel has both paddle wheels and a screw. The paddle wheels are located forward of the center, 27 ft. 6 in. diameter, with wooden arms and buckets all heavily cased in steel. The aggregate weight of each wheel is 66 tons. The 9 ft. 6 in. propeller wheel in the stern is especially designed for breaking heavy ice.

Each side wheel is driven by a pair of high pressure engines, geared at right angles to each other, with cylinders 28 in. diameter, 48 in. stroke. Engine shafts are geared to paddle wheel shafts by cast steel pinions 5 ft. 4 in. diameter, working in spur gears on wheel shafts, 16 ft. diameter, 5⅝ ft. pitch. These spur gears are built of cast iron centers, and arms in two pieces, and 12 cast steel segments composing the rim; all bolted, fitted, and keyed together.

The propeller in the stern is driven by a pair of engines at right angles; cylinders 28 in. diameter, 36 in. stroke, laid horizontal, with separate air pump and condenser. The screw shaft is 10 in. diameter and 52 ft. long, and is greatly inclined, as the propeller wheel projects 12 in. below the hull proper, being protected by a solid forged skag, which carries the bottom pintle of a solid forged rudder.

To protect the rudder when backing into heavy ice there is a heavy forging framed into the hull, immediately above the rudder, and extending down to the top line of it. The forging is covered by the outside plating of the hull, and when backing into heavy ice the rudder is put amidship and a heavy bolt inserted through the forging into the rudder frame from the deck, thus holding the rudder rigidly in a fore and aft direction. The after end of this forging extends down over the after corner of the rudder to prevent ice being driven in between the rudder and the horn.

In the forward engine room is located a beam engine; steam cylinder 16 in. diamter, 36 in. stroke, driving two air pumps and four bilge pumps; the center column of this beam engine forming a jet condenser, common to both side wheel engines.

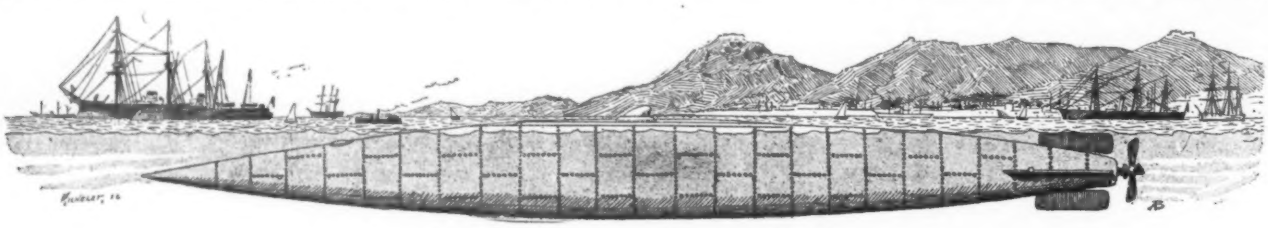
About the center of the vessel are located four marine return flue boilers of the rectangular fire-box pattern, 11 ft. 6 in. diameter, 16 ft. long, and carrying a working pressure of 90 lb. The aggregate grate surface is 252 sq. ft. and 9,828 sq. ft. heating surface. Along the center line of the ship, between boilers, are two steam drums connected to a steam separator. The smoke connections are carried to the side of the hull, where they terminate in smoke stacks, one on each side. Coal bunkers are located amidships, between boilers, extending the full length of the boiler room. On account of the great difficulty of getting water when working in ice, this vessel is provided with ten sea cocks located in different parts of the ship.

Both owners and builders feel confident that this vessel will be able to transfer cars across the Detroit River in the severest weather, breaking through the heaviest ice that can form there. She arrived at Detroit at 2:15 p. m., Jan. 13, and tied up to the Michigan Central dock, having made the run from Cleveland in 11 hours and 12 minutes, running for an hour and a half of that time under a slow check, and breaking her way through 50 miles of ice from 4 in. to 6 in. thick. Her average speed in open water was 12 miles per hour and about 10 miles an hour through the ice. She handles perfectly and steams easily with all her engines at maximum speed. Her side-wheel engines were started at 52 revolutions per minute and her propeller engine at 85 revolutions, making the trip to Detroit without any interruption whatever, excepting only when the speed was slackened by order of the pilot, without heating of journals, alteration or adjustment, from port to port.

The Transfer, as this vessel is called, was inspected on arriving at Detroit, by President Ledyard, General Superintendent Brown, and Assistant General Superintendent Miller, of the Michigan Central. On the voyage over, she was under command of Commodore Innes, of the Michigan Central ferry line, assisted by Captain McLaughlin, of the passenger steamer City of Cleveland. The machinery was in charge of Chief Engineer Westaway. Among the guests on board were ex-Mayor Geo. W. Gardener and Capt. Geo. W. DeWolf, U. S. Inspector of Hulls at Cleveland. Her builders were represented by H. D. Coffinberry, President O. N. Steele, superintendent of machine shops; T. W. Bristow, superintendent of the ship yards; and J. C. Wallace, superintending engineer. The weather was fine, and nothing occurred during the voyage to mar the pleasure of the trip or give anxiety to those most interested.—*Railroad Gazette.*

THE TORPEDO BOAT GYMNOTUS.

THE final trials of the Gymnotus, the first submarine torpedo boat of our fleet, have just been made in the roadstead of Toulon. For a wonder, in a first experiment, not the least stumbling block was encountered, and every prevision of our skillful and bold engineers, all of them Frenchmen, was wonderfully realized, even to the minutest details.



PROFILE OF THE GYMNOTUS.

The first plans of the Gymnotus were by the illustrious Dupuy du Lome, who thus continued the labors of Admiral Bourgeois. They could not be carried out for want of a practical motive power. The responsibility of completing his work was bequeathed to his friend and successor in naval constructions, Mr. Zede. The latter, two years ago, was still in search of that unfound motive power, when Capt. Krebs, who had just invented a light and powerful electric motor for the Meudon balloon, came to offer him the co-operation of electricity.

The two scientists set themselves to work, and the entire mechanical part of the boat was soon established.

The Gymnotus, as regards plans, was constructed such as it was seen in the recent trials.

Before carrying these plans out, it remained to proceed to preliminary experiments.

The first trial, made in November, 1876, with Reynier accumulators placed upon a torpedo boat, failed completely. Without losing courage, Messrs. Zede and Krebs addressed themselves to Messrs. Commelin, Bailhache and Desmazures, who had just got up a light, alkaline-liquid accumulator, and, on the 20th of September, 1887, with the same boat with which Mr. Reynier had failed, were made the successful experiments that finally gave our navy the electric torpedo boat.

Without loss of time, the engineers, sure of success, set themselves to work. Capt. Krebs had his 60 H. P. multipolar motor constructed, and Mr. Zede confided to Mr. Romazetti, engineer of naval constructions, the carrying out of the plans of the Gymnotus at the arsenal of Toulon, while Messrs. Commelin and Desmazures proceeded to the construction of the gigantic battery of 564 accumulators that was to have a capacity of 675 million foot-pounds.

The regretted Mr. Desmazures died quite suddenly last January, but Mr. Commelin, patriotically aided by Madam Desmazures, was enabled to carry out his part of the work.

In brief, on the 24th of last September, a year after being put on the stocks, the Gymnotus, finished, left the Mourillon slip, and, in two months, all being installed abroad, trials of it above and below water were proceeded with.

The new and terrible engine of maritime war that France now alone possesses has the form of a slender spindle, which might be likened to a huge Spithead automatic torpedo. It is constructed of thin steel

TRIAL OF THE GYMNOTUS, AT TOULON.

plate, weighs 37,400 pounds, and has a capacity of 30 tons. It is 65½ feet in length, and its diameter amidships is 6 feet, thus permitting a man to stand upright. Above, there is a narrow platform in which there is an 18-inch manhole to allow of the entrance of the crew. In the center, there is a small cupola provided with mirrors and reflectors that permit the commanding officer to see all that is going on outside of the boat and to steer under water.

The Gymnotus is set in motion by a powerful screw having four blades, and 5 feet in diameter. Its horizontal direction is secured by two ordinary rudders situated vertically one above the other, and its vertical direction by two lateral rudders.

The motor is a Krebs electric machine, having 16 poles arranged around a movable ring 3¼ feet in diameter and provided with a collector with 4 brushes—two for running forward, and two for running backward. It revolves 250 times per minute, and actuates the screw directly. The motor weighs 4,400 pounds, and is capable of furnishing a normal power of 60 horses, with a normal current of 220 amperes and an E. M. F. of 200 volts.

The electric energy is furnished by the battery of 564 alkaline-liquid accumulators finished by Mr. Commelin. Each accumulator weighs 38½ pounds, say a total of 21,714 pounds. Its capacity in energy permits of maintaining a speed of 10 knots for 6 hours.

Finally, the elements are grouped in four ways in order to obtain four different speeds.

We shall be sparing in detail as to the internal mechanism of the boat, which remains an absolutely patriotic secret. However, let us say briefly that the supply of respirable air is furnished by reservoirs of compressed air; that submersion to various profound depths is effected through reservoirs that are filled with water in the quantity desired, and which is afterward removed by powerful pumps when it is desired to rise to the surface; and, finally, that the whole—rudders, pumps, cocks, mirrors, etc.—is actuated by electricity.

The crew of the Gymontus consists of the officer commanding (Lt. Baudry of the Cantinnerie has been appointed to this choice post), two mechanicians, and one sailor.

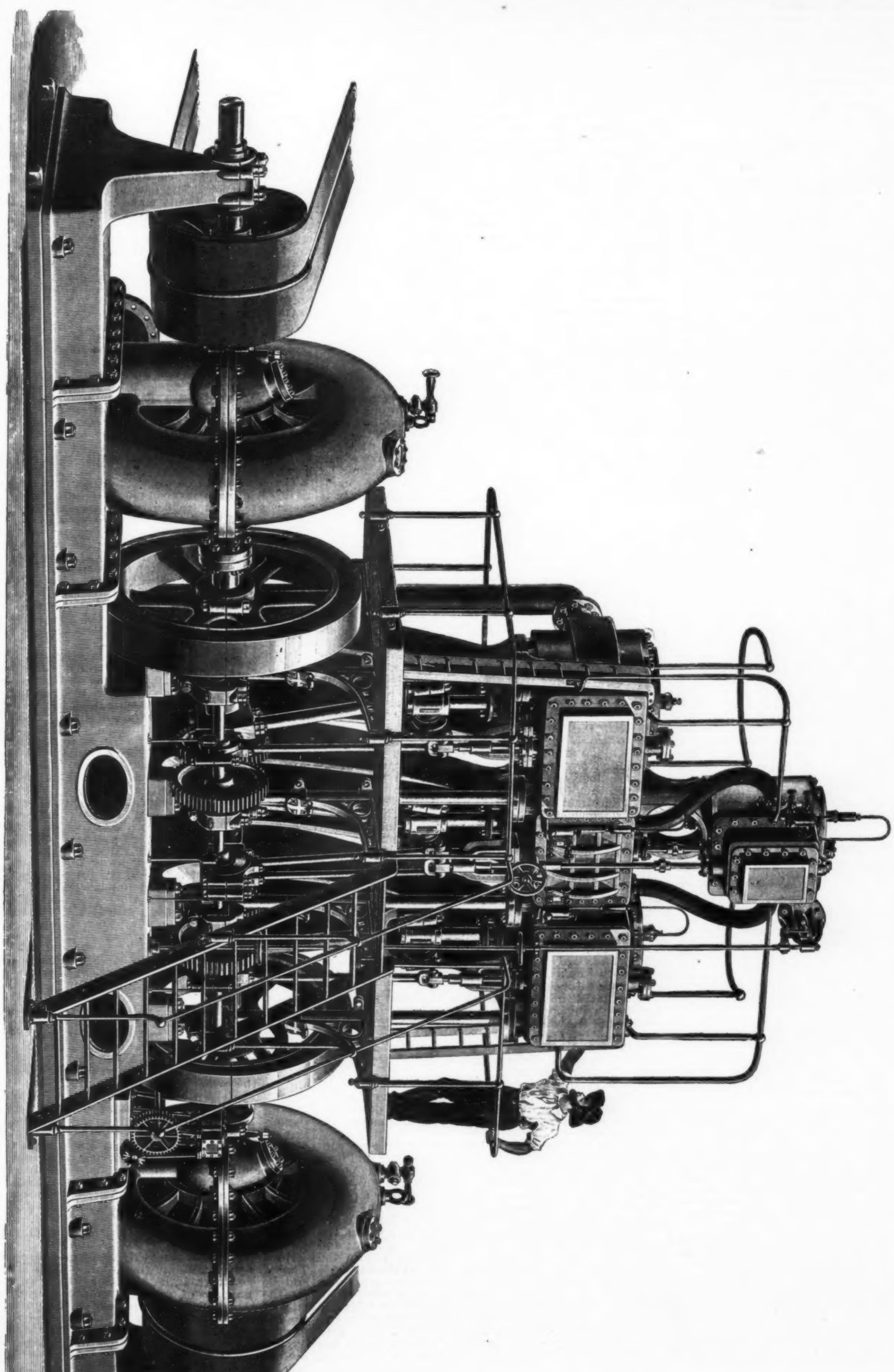
The trials at Toulon began in the Vauban basin and terminated in the roadstead. They astonished the privileged ones who were present. The boat moved like a fish, both on the surface and under water, and was kept with precision at the depth desired, and that too at every velocity, directing itself and taking every position demanded, with a rare facility.

The excitement was intense, as may be conceived, when the Gymnotus, which was then shooting along the surface, was seen for the first time to incline to the rear, then submerge the caudal appendage of its rudders, and finally disappear beneath the waves in order to pursue its way at a depth of about fifty feet. It was a true relief for all anxious hearts when, after a few minutes too long, it was seen to rise in an un expected direction and show, like a red blotch amid the seething waters, its back painted with red lead. The names of the five intrepid excursionists who took a place in the Gymnotus at the time of these interesting experiments are Messrs. Zede, Krebs, Romazetti (engineer of the boat), Baudry (the future commander), and Picon (chief of construction of the boat).

We cannot too often repeat that the completest success has crowned the efforts of Messrs. Zede, Krebs, Commelin, and Romazetti, who may be proud of their work and the power that their marvelous engine is going to give to France.—*L'Illustration.*

TRIPLE EXPANSION CENTRIFUGAL PUMPING ENGINE.

THE engraving represents a triple expansion engine having four cylinders of the following dimensions: High-pressure 16⅛ in. in diameter, intermediate 24½ in. in diameter, and two low-pressure cylinders 31 in. in diameter, all with 18 in. stroke. The cylinders are all steam jacketed and have steel liners. They are fitted with relief valves and cylinder, steam chest, and jacket, asbestos packed drain cocks. The general design of the engine was prescribed by Messrs. Chaffey Brothers to suit the requirements of their Australian irrigation colonies. The details were worked out by the makers, Messrs. Tangyes (limited), Birmingham. The engine was designed for an initial steam pressure of 140 lb. per square inch; an independent air pump and condenser is fixed at the back of the engine and is driven by a direct separate horizontal engine. The air pump is 13 in. in diameter by 18 in. stroke, while the steam cylinder is 10 in. in diameter by 18 in. stroke and is fitted with



TRIPLE-EXPANSION PUMPING ENGINES FOR THE MILDURA IRRIGATION COLONY, VICTORIA.

CONSTRUCTED BY MESSRS. TANGYES, LIMITED, ENGINEERS, BIRMINGHAM.

Tangye & Johnson automatic gear. The high pressure cylinder of the main engine is fitted with expansion gear on Meyer's system; it is variable by means of a hand wheel when the engine is running, and has an index graduated to the points of cut-off.

The intermediate and low pressure cylinders are fitted with trick slide valves to reduce the travel and permit of an early cut-off. The cylinders and covers are neatly lagged with sheet steel and felted to prevent radiation. The crankshaft is of steel 7½ in. in diameter, with cranks and couplings forged solid, and is machined all over. At each end of the crankshaft there are coupled two centrifugal pumps (four pumps in all) having 20 in. suction, and delivery pipes and disks 6 ft. in diameter.

Each pump is capable of delivering 8,000 gallons per minute to a total height of 35 ft. The speed of the engine and pumps is 180 revolutions per minute. The power of the engine being in excess of that required to drive the four pumps, pulleys are provided for driving by belt other pumps which have been previously supplied by Messrs. Tangyes. Owing to the great length of the crankshaft and spindles, the end pumps are driven by means of floating couplings on the principle of the Clements driver used on lathes. All the slide valve chests are turned to the front of the engine, a second motion shaft being fixed in front and driven from the crankshaft by steel spurwheels having the teeth cut from the solid. The piston rods are 4½ in. in diameter, and the pistons are fitted with spring rings and a junk ring, secured by wrought iron bolts having gun metal nuts and pegs. The crossheads are steel, and are fitted on the conical ends of the piston rods, where they are secured by cotters. A large gun metal slipper is provided. The crosshead pins are forged solid with two journals of large size. The connecting rods are of the marine type, 4 ft. 6 in. long from center to center. The diameter of the crank pin journals is 7¾ in., the length being 10¾ in. for the intermediate and high pressure cylinders, and 8½ in. for each of the low pressure cylinders.

The cylinders are carried on massive cast iron standards of the box form, bolted to strong flanges at the cylinder and the bed ends; the front sides are steadied by bright steel columns having solid flanged ends and carrying at their lower ends the journals of the valve motion shaft. A massive bed plate is cast with the main bearings, the brasses being in three pieces with wedge adjustment. The eccentric straps are gun metal and are lined with white metal, as are all the bearings and journals. A pair of barring engines to facilitate starting are fixed on the bed plates; these have cylinders 4¼ in. in diameter by 3 in. stroke, and are geared to the main shaft by means of a worm and wheel so arranged that the worm is thrown out of gear when the main engine starts. The whole of the engine and pumps are fixed on deep cast iron girders planed on the top side, the under side of the engine and pumps being also planed, thus insuring the greatest accuracy and freedom of working. A substantial platform is fixed round the engines; it is surrounded by a bright handrail, and is supported on cast steel brackets. The platform is approached by steps in front, and enables the attendant to have access to the upper part of the engine. The flooring is of checkered plates, except from A to B, where it is formed of bars. The engine is fitted with permanent indicating gear, special oiling arrangements to the moving parts for continuous running, and sight feed lubricators to the steam cylinders. Steam air ejectors and flap valves are fitted to the pumps for charging them with water before starting.—*Engineering.*

THE STEAM ENGINE—ITS PRINCIPLES, ITS DEVELOPMENT, ITS FUTURE AND PERFECTION.*

By E. N. Dickerson.

In the year 1830 our great countryman, Professor Joseph Henry, who was the pioneer discoverer in electro-magnetism in this country, after a series of investigations of the principles of electricity, produced the first electromotor ever known to man, and prophesied that future discoveries would be made that would render the principle then exhibited available and valuable. At that time galvanic electricity was produced only by the combustion of zinc in galvanic batteries, and Professor Henry pointed out that so expensive a fuel as zinc could not compete commercially with coal for the generation of power, and that, therefore, the electromotor must be limited in its uses to cases where some special convenience would compensate for the increased expense.

In 1831 Professor Henry in this country and Faraday in England, almost simultaneously, but independently of each other, discovered that electricity could be produced in indefinite quantities by the combination of horse power with a magnet; and electricity thus produced was called magneto electricity. This, the greatest of all the discoveries in electricity, opened the door to an unlimited application of power for its production, and it was left to ingenious electricians to invent forms of apparatus by which in the most effective and economical way the desired result could be accomplished.

The most important improvement, and which has practically superseded all others in the devices for developing the principles established by the discoveries of Professors Henry and Faraday, was made by Pacinotti, whose apparatus, modified subsequently by ingenious inventors, is now in universal use, producing practical results so near to the theoretical ones that more than 90 per cent. of the power expended upon the generating machine reappears in the form of electricity, leaving less than 10 per cent. to be saved (if it can be saved) by other improvements.

Founded thus upon the discoveries of the scientists, and practically applied to the arts by the inventors, a complete system for the creation and distribution of power through the intervention of electricity has sprung up, occupying the attention of thousands of skilled and scientific men, giving employment to hundreds of thousands of operators, and conferring upon humanity inestimable blessings. So far as we now know, this whole system depends upon the steam engine; and it must continue to depend upon that means for generating power until, in the future, the discovery shall be made of some means of converting the heat of combustion directly into electricity without the intervention of any other agency. When that is done—and it is entirely within the laws of nature—then the steam engine will disappear in connection with the generation of electricity; but until that is done, the steam engine is the important factor in the problem, and therefore is a subject of great interest to you, as electricians, both in a scientific point of view and in its practical application; and because of this connection you have honored me with your invitation to speak to you to-night on the subject of the steam engine, its past development, its present capacity, and its future limitations.

The subject is so large a one that within the compass of a single lecture it is impossible to do more than to give you an outline of its history and the principles upon which it operates, and which limit its capacity.

The first steam engine of which we have any knowledge (although, indeed, if the records had not perished we should have known much more on the same subject) was made by Hero, of Alexandria, more than two thousand years ago. It was a perfectly practical operative machine, and has been in use within a very recent period for the purposes of driving saw mills. Its principle is that of tangential reaction—the steam escaping tangentially at the periphery of a revolving wheel. Shortly after Hero's date, the progress of science and art, which had been very great in Alexandria, was arrested by that flood of ignorance and superstition which for ages chained down the intellect of man; and until Lord Bacon shed the light of his genius upon the world, philosophy and religion were united in despising the practical arts of life, by which the physical condition of humanity is improved, and, as a consequence, its intellectual capacity developed.

Under the new impulse the steam engine again appeared, but was used chiefly for the purpose of pumping water, until James Watt, about a century ago, took up the subject, and brought to bear upon it one of the greatest and most profound intellects which has ever been directed to the practical subordination of the laws of nature to the wants of man. The progress which he made was marvelous. He discovered all the laws which we now know with almost perfect precision, and he showed us how to apply them to produce results in almost perfect accordance with those laws under which steam must act.

Let us catalogue what this great genius did. He discovered the essential truth that steam must be condensed in a vessel other than the cylinder it is used in to produce power, as had formerly been done; and he invented the application of the air pump to the condenser in order to make a true steam engine—that is, an engine from which the air is excluded and in which the piston works between two vessels, the boiler and condenser, each of which contains steam, but of different pressures, the power resulting from that difference.

He invented two forms of condensers—the "jet condenser," in which the steam is cooled by a spray of cold water injected into it, to be used when fresh water is available; and the "surface condenser," in which the steam is separated from the cold water by a thin partition of metal, and is condensed by contact with the cold surfaces. Without this last invention our modern steamships could not carry high steam in their boilers, and could not attain their wonderful speed.

He discovered the law under which steam used expansively increases its power in a certain ratio; and he invented the best form of cut-off for utilizing this discovery known to man, until it was improved upon the same principles by Mr. Sickles, of this city, in 1842.

He invented the "indicator," an instrument which gives us a graphic representation of the forces exerted by the steam, and proves the truth of the laws he discovered.

He invented the "single puppet valve" for admitting and excluding steam from the engine, which is theoretically perfect, *and without which it is almost impossible* to make an engine give the full value of the steam used in it. There ought to be a statute in the interests of humanity, requiring all engines to use it when the rate of speed is not so high as to compel the use of the inferior slide valve: in the interest of humanity, I say; because it would save a vast amount of coal in the ground for future generations.

He invented the steam jacket to surround the cylinder with an envelope of hot steam, in order to preserve the heat of the steam within, while expansion is occurring and giving out power.

He invented the "fly-ball governor" for maintaining uniform speed of the engine under various conditions of load and pressure.

And he invented a great number of subordinate details, too numerous to mention here; and, as if to admonish the world not to depart from these principles, he invented the "copying press" now in common use everywhere.

When he died he seems to have left no successor capable of appreciating the discoveries he made; and for a generation after his death the art of producing power from fuel by the intervention of a steam engine retrograded, so that less power was obtained from a pound of coal consumed than could be obtained by the use of methods invented and fully explained by James Watt.

The problem of the steam engine is to convert the potentiality of combustion into dynamic energy; and that steam engine is the best which can obtain the most power from the least coal. In the eternal cycle which with God began, force in a protean form remains constant; and whether it is applied to the uses of man or whether it is expended in some useless or injurious effect, depends upon how nearly imperfect man can obey the laws of nature in dealing with it. You, gentlemen, are dealing with one form of force which has eluded thus far all investigations into its substance; but it is but one section in the cycle, and is necessarily coupled to what precedes and what succeeds it under the immutable laws of the correlation of energy. You and your predecessors have dealt with this form of force as it has passed through your hands with wonderful success. The talent that has been given to you has not been wrapped in a napkin and buried in the ground. It may be truly said to you, "Well done, good and faithful servant;" for you have converted dynamic energy into electricity, and delivered it for conversion into light or some other form of force almost unimpaired. You have lost by the way less than one-tenth of the force that has been committed to you for transference; and it is difficult to imagine greater perfection than that. But those who have had to deal with the transference of force through the steam engine stand almost in the exact reversed condition; for they transfer hardly more than 10 per cent. of the power, and lose 90 per cent.; whereas you transfer 90 per cent. and lose but 10 per cent.

When the great Creator, in the construction of this world, separated the carbonic acid of chaos into its two constituents, and stored away the carbon for the use of man, while the oxygen was liberated in the envelope of the earth, ready to again combine with the carbon, and again produce the force which had been expended in disuniting them, the problem presented to imperfect man was the production of so much force, by again uniting these dissevered elements, as had been expended in separating them. The plain injunction given to him is—be economical of these resources, for they are limited. The coal deposits when once exhausted cannot be renewed; and the existence of civilization on the earth in its present form depends upon the supply of available carbon. The new application of it to the generation of electricity makes a still further demand upon that supply; and as we look into the distant future we can foresee the time when that supply must fail. Therefore, it is our duty, both to our generation and those who succeed us, to husband those resources against a day of famine. But to do that we must understand the principles upon which the result depends, and learn how to intelligently apply them, and our first duty is absolute obedience to the law of nature in the construction of any machinery whereby we propose to convert a pound of coal into horse power.

The first fact to be discovered is the amount of power which is inherent in the reconversion of carbon and oxygen into the carbonic acid form in which they formerly existed. That is the work of the chemist, and it has been well done many years ago. In round numbers it may be said that a pound of good coal perfectly consumed can produce heat enough to convert about 14 pounds of water into steam, but it varies with the quality of coal. The best boilers will convert about ten pounds of water into steam with a pound of coal burned, so that the loss in that step is not very great.

The next fact to discover is the amount of force which results from the conversion of water into steam. That fact is fixed, and can neither be increased nor diminished by man's ingenuity or efforts. As a convenient unit to remember, and near enough to the truth for all practical purposes, a cubic inch of water converted into steam by whatever means, or under whatever circumstances, will lift a ton of 2,240 pounds one foot high. A cubic inch of water, a ton of weight, and a foot lift are the simple units. Beginning on that base line, in the direction of the boiler, it becomes important to so organize it as to obtain the greatest evaporation from the fuel burned, and to lose the least amount of heat.

In that direction very great perfection has been attained. A practical and good boiler will evaporate about 80 per cent. of as much water as the fuel burned is capable of evaporating, if there were no part of its energy expended otherwise than upon the water; and there is but little left to save. In the other direction, however, the problem is much more difficult. If the engine should be so constructed as to use simply the pressure of steam as it is evolved from the water, then, obviously, the whole effect possible to be produced would be at the rate of a ton a foot high for each cubic foot of water evaporated in the boiler; and that was the condition of the steam engine when James Watt undertook its improvement. In that condition—called "full stroke"—the steam while in the cylinder does no work whatever. It might as well be oil, or any other liquid or fluid. The work it does was done when it emerged from the form of water into steam in the boiler, and pushed out of the boiler the steam above it, which already had done similar work.

Under those conditions, the engine might do less, in consequence of imperfect construction, radiation, and leakage, but it could not possibly do more. James Watt, however, perceived that after the steam had lifted a ton a foot high for each cubic inch of water contained in it, it was in the condition of a compressed spring which, if a part of the weight were removed, would be capable of lifting a remaining part of the weight to a greater height than a foot; and so on as the weight might be diminished. Or, to illustrate: Suppose a cylinder of one square inch area with a cubic inch of water in the bottom of it; and suppose a piston resting upon that water sustaining a platform at the upper end of it on which a ton of bricks is piled up. Now apply heat to the bottom of that cylinder, and as the water is converted into steam that ton weight of bricks will be lifted one foot high, and there it will stop—all the water having been converted into steam. But the steam spring would be under a pressure of more than 2,000 pounds to the square inch, and obviously capable of exerting an immense deal of force, if any means were devised for giving it the opportunity by expanding. Now, suppose one of the bricks to be knocked off the platform, then, the load being diminished, the steam spring would expand somewhat and lift the remaining load a little further; and so by degrees the entire weight might be removed, while the steam spring would be continually expanding until it should come to the freezing point or lower.

How much power can be derived from this operation? That was the question which James Watt answered; and he constructed the indicator which we now use for the purpose of giving a graphic representation, on a piece of paper with a pencil, of the power in all the stages of its development; and he found that that power corresponded very nearly with the curve of the hyperbola; so that the equation of the hyperbola represents practically the power to be derived from permitting steam to expand after it has been used for all that it is worth as it comes from the water. Without refining, a few figures will be instructive. If the steam be allowed to expand into twice its original volume, it will add 69 per cent. to its normal power of a ton a foot high; or it will lift one ton and $\frac{69}{100}$ a foot high for each cubic inch of water. If it be allowed to expand three times, it will lift two tons a foot high. Ten expansions will lift three tons and $\frac{3}{10}$ a foot high. One hundred expansions will lift five tons and $\frac{6}{10}$ a foot high; and, obviously, all the weight lifted beyond the original ton a foot high is clear gain by applying the principle discovered by James Watt.

Then, there is another law of steam which James Watt also discovered with wonderful accuracy, which

* An address recently delivered before the Electric Club, New York.

is, in substance, that no more heat is required to evaporate a pound of water under high pressure than is needed to evaporate it under the atmospheric pressure, or any other low pressure. That is not strictly true, but it requires the most refined and accurate experiments to detect the variations; and those experiments were made by Regnault, the French scientist, under the auspices of the French government, 40 years ago, who finally determined the exact truth, which does not practically vary from the formula of James Watt and Dr. Black, his associate.

Those of you who were educated more than 30 years ago will remember that the text books stated that "*the sum of the sensible and latent heat of steam was constant*," which was believed to be true by James Watt. The fact is that a very little more heat is required to evaporate water under high pressure than under low. Regnault's equation shows the addition to be $\frac{3}{10}$ of the sensible temperature, and it may be disregarded for all practical purpose in calculating the power of the steam engine.

Under this law, therefore, the higher the steam is carried, the longer the range of expansion can be carried without reducing the pressure below the point at which it is practically efficient, and hence the advantage of carrying high steam; but there is no advantage in carrying high steam unless it be accompanied by long ranges of expansion; on the contrary, there is a loss, because it is more likely to leak and is destructive of machinery.

These three laws are the key to the whole problem:

First.—A cubic inch of water will lift a ton a foot high converted into steam.

Second.—It costs no more fuel to evaporate a cubic inch of water at the pressure of 200 pounds to the square inch than it does to evaporate it in an open vessel; and

Third.—The gain of power depends upon the number of times the compressed steam is permitted to expand after it has done the work of lifting a ton a foot high.

Founded upon these principles, the steam engines which were made by Mr. Watt and his associates and pupils before 1830 produced a horse power with less than two pounds of coal an hour. These engines are known as the Cornish pumping engines; and if you will look into the history of these machines, you will find them reported as doing a "*hundred millions of duty*;" which is a technical phrase intended to express the fact that a hundred million pounds of water were lifted a foot high for a hundredweight of coal consumed. Turning that into horse power, it means about two pounds of coal an hour a horse power. This result was produced by cutting off steam in the cylinders at one-eighth or one-tenth of the stroke, and allowing it to expand eight or ten times. The engines of that day, of course, were very imperfectly constructed, and great losses occurred from leaking pistons and from imperfectly constructed boilers; but notwithstanding that loss, the result was equal to two pounds of coal an hour a horse power.

Executing the drawings of these engines with the tools and machinery of to-day and the result would be appreciably higher. Or in other words, an engine expanding steam ten times, and evaporating eight pounds of water to a pound of coal in the boiler and without any losses from leakage, ought to make a horse power with a pound and a half of coal an hour. These results were obtained by obeying Watt's laws, which I have stated, as nearly as it was possible then to do.

Obviously, two conditions are essential to a perfect obedience of these laws:

First.—The valves of the engine must be absolutely tight when closed; and

Second.—The closure of the steam valve, when the time for cutting off has arrived, must be instantaneous.

With these two conditions, the engine in other respects being practically perfect, the theoretical conditions will be practically attained. But in proportion to the defects in those conditions, the losses will increase. James Watt complied with those conditions in respect to his valves by making them absolutely steam tight. They were what is called "single puppet valves"—that is, a tapering plug fitting into a tapering hole with the steam pressure on the upper side. When the plug is ground into the hole, then the heavier the pressure upon it, the tighter the valve fits. When it is open the steam flows through. When it is shut the steam is absolutely excluded. That single puppet valve was one important element of economy in those pumping engines. The accompanying sketch, Fig. 1, illustrates it.

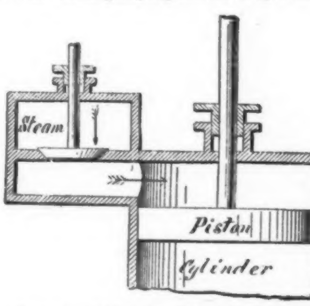


FIG. 1.—JAMES WATT'S SINGLE PUPPET VALVE.

The next element is more difficult to perfect. In James Watt's machines these single puppet valves were closed as rapidly as mechanism would endure, by the mechanical movement of the engine itself. But unless the valve is closed *instantaneously*, the steam is "*wire drawn*" through the contracting aperture while the piston is running, and as a consequence a great loss of power results.

More than 40 years ago Mr. Sickles, then an apprentice in the Allaire Works in this city, invented an instantaneous closing valve, which he did by detaching the valve from the lifting mechanism, driving it shut with high speed, and arresting its fall at the instant of closure by confining a fluid in a cup; and inasmuch as water or air can be pounded forever without injury, no destruction resulted. The improvement perfected the mechanism for carrying out James Watt's laws. It was adopted afterward by Corliss and most other stationary engine builders, and is the only reason for the improved efficiency of that class of engines.

It is the only radical improvement in the steam engine which has ever been made since James Watt left it.

We now hear much of double expansion or compound engines as if they were a novelty, and as if there were some mystery about them. They were perfectly well known to James Watt, and several patents upon them were taken in England, by Wolf and others, in the early part of this century. Their improved efficiency depends simply upon the fact that the steam is allowed to expand through two or three cylinders, whereby a greater range of expansion can be obtained than can conveniently be had in a single cylinder. But no greater effect can be obtained than is due to the expansion of the steam under the law discovered and stated by James Watt. Much less than that is obtained in practice in these engines, because of the losses incident to the transference of the steam from one to the other of the cylinders.

In 1825 several steamboats on the North River worked by double expansion engines were built by Mr. Allaire in this city—the Henry Eckford, for one, and the Sun, which made the trip to Albany in about 12 hours, for another. At that time the subject was not well enough understood, and economy in fuel was not considered of so much consequence as the first cost of construction, and these engines were not largely reproduced. One of these double expansion engines made in England was brought to this country in 1830, and for many years was used in the oil factory of Judd's Sons, giving very economical results. When they needed more power, a single expansion engine was made for that factory and added to the other, but its results were vastly inferior to that of the compound engine.

When steamships came to be built in England in 1840 and afterward, nothwithstanding the fact that high expansion with great economy was in constant operation on James Watt's Cornish engines and on Wolf's compound engines, no attempt was made to work the marine engines under high expansion; and as a consequence all the earlier steamships, for more than 30 years, were running at a cost of at least four pounds of coal an hour a horse power; while at the same time compound engines had been well known for a generation, and were in actual use, making a horse power for about two pounds of coal an hour. The Cunard company, however, were making money in their business, and they considered that a sufficient answer to any suggestion that their fuel account was enormously expensive.

This condition of things continued until about 1860, when Mr. Jameson, an English engineer in charge of the steamships of the South Pacific Steamship Company, which was losing money because of the great price of coal at Panama, induced his company to send one of their ships to England, and replace its engine with a double expansion engine. The improvement of course was enormous, and all of those ships were sent round the Horn to England, and fitted with high expansion engines, thereby converting a losing into a profitable business. This experience astonished the English steamship owners, and the White Star line began to use compound engines, which has been followed up from that day to this, and now they are running about as economically as James Watt's engines were running more than half a century ago; that is to say, at the cost of two pounds of coal an hour a horse power.

Some of the more recent engines, carrying expansion still further, have reduced their fuel somewhat below that mark, and of course as expansion increases, the consumption of fuel will diminish.

In this country the early steamboat engines adopted James Watt's single puppet valves, which are absolutely perfect for a steam engine, but they did not have the cut-off of James Watt, although they used another kind, and therefore did not get the full results of Mr. Watt's plans. Their single puppet valves, however, were of immense value; and Commodore Vanderbilt, who was a very keen observer and a very able man, told me that he had observed that his old steamers on the North River produced power with less fuel than his improved modern steamers, which was undoubtedly true—the reason being that the modern steamers abandoned the single puppet valve of Watt, and substituted for it what is called the balanced valve. That change was made for the purpose of rendering it easier for the engineer to lift the valves by hand with a starting bar, when the engine needed to be worked in starting and stopping; because a single valve has the pressure on the top of it, and as it is made larger, the force to lift it becomes proportionately increased. A little steam cylinder would do the work at no cost, but that was not thought of then. The single valve is absolutely tight, but it is impossible to make a balanced valve tight; and the consequence of that change, which was made about 40 years ago, has been to waste by leakage through the engine at least 15 per cent. of all the coal that has ever been burned from that date to this in steamboats; and that continues this day. The astonishing fact exists to-day that on an average every steamboat running on the waters of New York *is wasting certainly not less than 15 per cent.* of all the fuel consumed by leaking through the valves; and almost any one of them will run at the rate of four or five miles an hour without ever opening the steam valves at all, and simply by the leakage through those valves; and that leakage is the difference only between what leaks in through the steam valves and what leaks out through the exhaust valves. Some of these steamboat engines are so constructed that the engineer can unhook the steam valves without unhooking the exhaust valves, so that as the engine moves, the exhaust valves are working and the steam valves are shut. That is particularly true of some of the steamboat engines on the New Haven line, and when the pilot rings the slow bell, as he frequently must do in going through crowded thoroughfares, the engineer simply unhooks the steam valves and lets them drop shut, and the steamboat moves on at a fair rate of speed from the leakage alone; whereas if those steam valves were tight, the engine would be stopped in half a revolution. This tremendous loss is not appreciated, because it is a case of internal hemorrhage, and no visible sign appears. The steam leaks into the condenser and is pumped overboard with the condensing water; but as far as I have observed, it has not raised the temperature of Long Island Sound at all, and therefore has not produced any effect on climate; and so far as I can see, there is no advantage gained by that tremendous expenditure. The remedy, of course, is very simple, and that is to go back to James Watt, which would mean at least 15 per cent. of saving in the coal bins. The accompanying sketch, Fig. 2, will illustrate it:

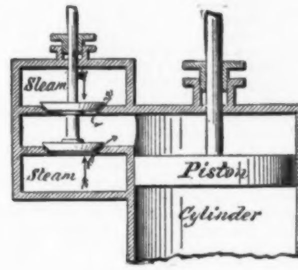


FIG. 2.

In the history of the development of the steam engine one curious phenomenon deserves to be mentioned, and that is the attack upon James Watt and his laws of steam by the government of the United States during the rebellion, when vast sums of money were expended in building steam engines. At that time the government officially pronounced its judgment of condemnation upon the laws of Watt, and published that judgment in a book which was distributed to the engine builders and engineers of the country as the authoritative decision of the United States. This absurd conclusion was reached in consequence of some experiments ignorantly tried by the government engineers on a leaky engine on Lake Erie, which, as the table showed, was using more than twice the fuel to the horse power that James Watt's engines were using. What was proved by the experiment was that such a machine as that was not a good one to work expansion on; but it was assumed that it proved there was no use in expansion. I quote from that book the following:

"The results obtained from this engine [that is, the Lake Erie engine] are rigorously applicable to all others in which saturated steam is employed in a cylinder, not jacketed, and *show conclusively the utter futility of attempting to realize an economical gain in fuel, under such conditions, by expanding the steam beyond the very moderate limit of one and a half times*, and that if the expansion be carried to *three times, a positive loss is incurred*. Also, that if measures of expansion as high as those due to cutting off the steam at $\frac{1}{4}$ or $\frac{4}{15}$ of the stroke of the piston are employed, *the economy is considerably less than with steam used absolutely without expansion*."

Upon that principle the whole steam navy of the United States that was built during the war was constructed. This was a tremendous blow to progress, from which we have not yet entirely recovered; and but for the fact that the engineers of Europe have built their magnificent steamers, and carried expansion to a high degree, we should have been building a navy to this day in accordance with this ignorance. But James Watt, for a dead man, made a magnificent fight in defense of his principles; and the money and the resources of the United States have utterly failed to defeat him.

Another singular fact connected with this performance, and illustrating how far the authority of a great government is felt in the world, even when employed to disseminate the grossest errors, is that in the recent edition of the Encyclopædia Britannica, in an article full of apparent learning, these experiments by the United States government are cited as authority for most absurd nonsense.

The new steamer Vesuvius, built by Mr. Cramp in Philadelphia for the government, and exhibiting higher speed than any similar vessel known, expands its steam seven times, and its performance vindicates the law.

In considering the question of economy in engines to be used for the generation of electricity, it is to be remarked that on account of the first cost, and the difficulty of always obtaining condensing water, the so-called high pressure engine has to be largely relied upon for generating power. That is only partially a steam engine. It is driven by steam on one side of the piston, but it is resisted by the atmospheric pressure on the other side, and consequently there is a constant back pressure of 15 pounds to the square inch, which has to be driven out and paid for in fuel without any beneficial result on the work to be done; and therefore high economy cannot be obtained in a non-condensing engine; whereas in a steam engine *proper* the back pressure may be reduced to one pound to the square inch, and, therefore, it forms a very small proportion of the total work done, leaving a much larger proportion for useful effect. Whenever, therefore, the conditions permit it, a condensing engine should be employed, out of which the maximum economy can be obtained.

The present efficiency of the best non-condensing engines is probably not greater than at the rate of two and a half pounds of coal an hour a horse power, and of a good condensing engine about two pounds of coal an hour a horse power, or not materially different from James Watt's engines of 50 years ago. At the rate of two pounds of coal an hour a horse power, the engine is developing about one-tenth of the power which the coal is giving out in combustion, and nine-tenths are lost; and the question is, what are the limitations upon the steam engine beyond which practically it cannot be expected to pass in diminishing the consumption of coal in comparison with horse power? The enormous loss which I have mentioned is due to the fact that the steam in steam engines can be expanded only to a very limited extent. The temperature of combustion may be taken at 2,000 degrees, but the water and steam on the opposite side of the thin boiler plate which separates them from the fire may be only 350 degrees hot, which represents 125 pounds to the square inch; whereas, if material could endure the temperature, and boil-

ers could be made to bear the pressure, steam might be carried at 1,000 pounds to the square inch, and the temperature at 550 degrees, and it would cost a very little more fuel to make the steam at 1,000 pounds pressure than it costs to make it at the atmospheric pressure. At the pressure of 1,000 pounds to the inch the steam might be expanded 1,000 times, giving eight times as much power as when used without expansion. But practically this cannot be done because material will not endure the heat, the pistons cannot be kept tight, and a little leakage of such valuable steam would destroy the economy. Perhaps the limit to which pressure can be carried practically, with our present knowledge of material and of construction, is 250 pounds to the square inch; at which steam may be expanded 100 times, when it would give $5\frac{4}{10}$ times as much power as without expansion. Under those circumstances, a horse power should be made with about three-quarters of a pound of coal an hour; and so far as I can at present see, that is about the limit of economy attainable, and that would give us about one-quarter of the power of combustion in dynamic effect.

It is my opinion that with our present knowledge of machinery a steam engine can be built that will produce a horse power with three-quarters of a pound of coal an hour, if of sufficient size to reduce the percentages of loss by radiation to a minimum. Under those circumstances, your fuel expense would be less than one third of what it now is.

The future before men of your profession is brilliant indeed. The doors were opened wide by Henry and Faraday, and already you have explored far beyond their imagination. The uses of electricity are now only beginning; and in a short time it will be the docile companion of man's labors, where now it is dreaded as the treacherous slave. Study the laws of nature, which are the thoughts of God, and do not attempt to rebel against them. We cannot create new laws, nor produce force.

"In pride, in reasoning pride, our error lies,
All quit their sphere, and rush into the skies.
Pride still is aiming at the blest abodes,
Men would be angels, angels would be gods;
Aspiring to be gods, if angels fell,
Aspiring to be angels, men rebel;
And who but wishes to invert the laws
Of order, sins against th' eternal cause."

Do not commit that error; but, obedient to the laws, work on in adapting them to the uses of man; and the time is not far distant when with steam power, at the rate of three-quarters of a pound of coal an hour a horse power—or its equivalent in petroleum—and with 95 per cent. dynamos, you will take possession of the whole field wherever horse power is to be used for the convenience and elevation of man.

[Continued from SUPPLEMENT, No. 685, page 10941.]

THE CANADIAN PACIFIC RAILWAY.*

By THOMAS C. KEEFER, President Am. Soc. C. E.

THE EQUIPMENT OF THE LINE.

THE Canadian Pacific Railway is a modern road, having had the utmost freedom of location in unoccupied territory, for stations, yards, and shops, and has not therefore been handicapped by costly accumulations of antiquated rolling stock, or hampered by limited yard accommodation on any portion of the contract route—conditions which have proved so onerous to some older roads.

The divisional points are placed as nearly as possible at intervals of 125 miles, any variation from this being due to the questions of suitable station ground or water supply. At these points, the tracks are arranged as shown on the standard plan, the object being to provide a yard that may be readily extended—one in which the main track is broken as little as possible by switches, and so arranged that any car in the yard may be reached by one shunt.

At alternate divisional points, shops are established of sufficient capacity for repairs of rolling stock on two working sections, and at the divisional points between these there are smaller shops with the few necessary tools for ordinary breakages. Engines run from the larger shops to the smaller ones, so that ordinarily they return to the principal shop points every other day.

At all divisional points, the water tanks are erected 40 feet high, to give a sufficient pressure for washing out engines.

At the alternate points, wrecking cars, pile drivers, tool cars, bridge and track material, are provided for any emergency on the sections either way from them, and a smaller supply of emergency material is kept at the intermediate points.

In the newer country, stations are arranged at intervals of about 16 miles, governed by ground and water supply, with accommodation for two section gangs of eight men each, a combined freight and passenger station, a 50,000-gallon tank, and a telegraph office, insuring collection of section gangs for any emergency in the shortest possible time. These regular stations have side tracks according to trains handled on the division, and, where local traffic exists, a business track as well as a passing track. Passing tracks are laid about half way between these stations, making the crossing interval generally eight miles; but this is reduced where there is considerable traffic.

At Montreal, the principal eastern terminus; at Vancouver, the Pacific terminus; and at Winnipeg, which is midway between them and has 24 miles of sidings, large shops exist for heavy repairs of cars and locomotives. As these three points are 1,500 miles apart, large intermediate shops will be required as traffic increases.

Fuel Supply.—The fuel supply is: Nova Scotia coal for the eastern system, which is carried a short distance west of Ottawa; Pennsylvania coal from this point to Brandon, on the prairies, the first divisional station west of Winnipeg. This coal is brought by rail across the St. Lawrence and Niagara rivers, and by water to Lake Superior. West of Brandon, Canadian tertiary coal from the Bow River deposit is used, until it is met in the mountains by the Pacific coast coal from Vancouver Island. The Bow River coal is estimated to be within fifteen per cent. of the value of Pittsburg coal. Anthracite is being worked alongside the main line in the Rocky Mountains and is used for passenger cars and domestic purposes as far east as Winnipeg, but export is as yet chiefly to San Francisco. When more extensively mined and fire boxes are altered to burn it, it may displace other coal in the mountain section.

Windmills have proved successful for pumping on the prairies. The water is prevented from freezing by a heating pipe passing up through the center of tank.

Locomotives.—The consolidation engines working the Selkirk division were built at the company's shops at Montreal. They are distinguished by their short stroke, 22 inches, high boiler pressure, 160 pounds, and large grate surface to maintain this pressure. Their weight, $94\frac{1}{2}$ tons, is sufficient to prevent slipping in good weather, when hauling full train of seven coaches, without the use of sand, but this is provided both front and back for bad weather. The tractive force is 155 7 pounds per pound pressure on pistons, the wheel base short in proportion to diameter of drivers, and being carefully counterbalanced, they run with speed, ease, and steadiness around sharp curves. Their brake power is the Westinghouse on two forward pairs of drivers and the American steam brake on the two hind pairs. The water brake is also applied to all engines running in the mountains. The automatic brake is used in ascending and straight air in descending, with hand brakes manned. The block system, with telephone addition, is extensively used in the mountains.

The principal dimensions are:

Diameter of cylinder and length of stroke, 19 × 22 inches.
Distance apart of centers, 6 feet 11 inches.
Length of connecting rod, 9 feet 2 inches.
Driving wheels, diameter, 4 feet 3 inches.
Driving wheel tires, width and thickness:
First and fourth, $5\frac{1}{2} \times 3$ inches, flanged.
Second and third, 6 × 3 inches, blind.
Fixed wheel base, 14 feet 3 inches.
Total wheel base of engine, 21 feet 3 inches.
Center of cylinder to center of driving axle, 13 feet.

Weight on track in working order ..	13,100 lb.
Weight on drivers in working order.	90,900 "
Total weight of engine................	104,000 "
Weight of tender, empty............	35,000 "
Capacity of " coal................	20,000 "
" " water................	30,000 "
Total engine and tender, in working order........................	189,000 "

Snow Plows.—In winter these consolidation engines are furnished with a large, heavy pilot plow. This plow has rendered excellent service, and has repeatedly opened the way through packed and saturated snow, where the large wing plow had failed, enabling the latter to follow with wings wide open, nose down and flanger working, securing a good rail. These plows are of $\frac{5}{16}$ iron, double plated at nose, steel angles, and 6 inch by 1 inch iron strap stays. The height of nose is 5 feet and of wings at ends $7\frac{1}{2}$ feet, clearing a width of 9 feet at bottom and 10 feet at top.

The regular snow train has a strongly built plow, wings 16 feet across, and nose 11 feet above rail, the lower or horizontal portion of which is raised or lowered from inside, and when pressed down by weight of snow, is carried by rollers running on top of rails. The flanger is adjusted to turn over on meeting any obstruction harder than ice or packed snow. For this train Y's are put in, through which the whole train can be turned and seesaw back and forth, giving no rest to the wicked drifts or slides. "*Principiis obsta!*" is, during snow storms, the motto on the crest of the Selkirks.

For the efficient working of the snow plow train, it has been found necessary in many places, and where possible, to remove the line out from the hillside, to leave room for the accumulation of snow on the slopes, and a chance for the inside wing of the plow. This consideration is apt to be overlooked during a summer location in a mountainous, snow-affected region, especially when working against time, or upon too economical lines. The teachings of experience in the Selkirks have been many and valuable, and none more so than this—the question of sea room for the plow, and of store room for the snow.

The freight engines are heavier and more powerful than the passenger ones; cylinders 20 × 26; 4 pairs of 48 inch drivers; wheel base, 21 feet 11 inches; driving wheel base 14 feet; weight, 116,000 pounds; weight on drivers, 102,000 pounds. These engines haul 12 loaded cars up the Selkirk slope, which has grades of 116 feet per mile. In descending long, heavy grades with these trains, frequent stoppages are made to cool off, and prevent breakages in the cast iron plate wheels. This precaution is not necessary with passenger trains, in which no cast iron wheels are used.

On the Selkirk division steel rails of 72 pounds weight per yard are used, with 3,500 ties per mile.

Provision Magazines.—The company have omitted no precautions to secure the safety and comfort of passengers. For hundreds of miles no supplies can be procured except by train, and in view of detentions, each through train from Montreal, in addition to the dining car supplies, carries, in the baggage car, an emergency box of provisions, to be used exclusively for passengers, and only in case of necessity. Besides this, at nine points on the Selkirks and Eagle Pass, where detention by snow slides is possible, provision magazines are established in safe positions, at intervals of about ten or twelve miles; so that no train may be caught more than six miles from food. These provisions are emptied in the spring and replenished with fresh supplies in the autumn. Coal and oil supplies for the passenger cars are also similarly "cached," and emergency fuel for the locomotives; bridge and track material are held loaded on cars, to shorten detention of trains.

Extremes meet—the voyageurs of the Hudson Bay Company, Arctic explorers, and the hunters and trappers in the mountains, cached their surplus stores against the ravages of fire, of the loup cervier, the wolverine, or the polar bear; and now the most recent specimen of the highest type of transportation confirms, by its emergency magazines, the wisdom of the pioneers in the old time before the railway era.

PROSPECTIVE TRAFFIC.

The Canadian Pacific Railway has been opened for traffic through 2,500 miles of territory almost uninhabited, and so rapidly that settlement could not keep pace with it. The 1,900 miles and over of main line constructed by the company has been built in half the time allowed by the contract, and within these five years a subsidiary system, about 2,300 miles in length, has been built or acquired, by which the main transcontinental line has already been made more than self-sustaining. The capital account is not yet closed; another five years will be required to convert temporary into permanent work, and new demands will arise from extension of traffic, both on the prairies and in the mountains. Under these circumstances, no adequate conception of its importance can be formed without some consideration of the character of the country it traverses, and upon which its future depends.

The Eastern Section.—The starting point of the national road, as a government work, was a point near Lake Nipissing, called Callander, about equally distant from Ottawa and Toronto, and about two hundred miles due north from the latter. This point had no connections, and no special merit but that of being equally inconvenient to the rival provinces of Ontario and Quebec, both of which were placed on equal terms in reaching it with their provincial lines. One hundred miles west of Callander is Sudbury, the junction of the important line from St. Paul and Minneapolis *via* Sault Ste. Marie, by which those cities find their shortest all-rail route to Atlantic tide water. Sault Ste. Marie is rather nearer to Montreal than Detroit is, with the advantage that, like the Niagara and St. Lawrence rivers, its broken navigation makes it a bridge route.

It is not necessary to refer to the country east of Sudbury, which is a lumbering, agricultural, and mining region, quite capable of sustaining a railway, even without the traffic of the Sault route. From Sudbury westward the line cuts through continuous forest for 360 miles, until it strikes the shores of Lake Superior, which it skirts for 200 miles, and then leaves in a very direct line through a forest and lake region for the outlet of the Lake of the Woods, nearly three hundred miles farther west. The 850 miles from Sudbury to Lake of the Woods is through a country of similar character—a mountain and lake region—with very limited arable areas, but very promising mineral ones, and with an immense supply of timber invaluable to the railway, but much of which is, at present, commercially beyond the reach of market. Innumerable lakes, some more than 20 miles in length, are tapped by the railway, which, with their thousands of miles of coast line, will yield valuable supplies of timber, as soon as the nearer ones are exhausted, or the price makes exportation profitable. The 200 miles shore line on Lake Superior, with excellent harbors at the extreme points, afford landing places for water-borne coal from Ohio and Pennsylvania, for carriage east and west, as well as reach the valuable fisheries of the coast.

Near Sudbury and Port Arthur, gold, silver, copper, and iron have been discovered, and, with the exception of the iron, are being worked. Upon the extension of these discoveries, in what is all known to be a mineral region, between Sudbury and the Lake of the Woods, as well as upon the lumber trade, the building up of a local traffic will chiefly depend.

The Lake of the Woods has an area of 700 square miles at an elevation of 1,062 feet above tide water. Its drainage area is about 25,000 square miles, 7,000 miles of which are in Northern Minnesota, which its water-shed penetrates to the head waters of the Mississippi at Lake Winnipegoshish. In Canada its water-shed begins within thirty miles of Lake Superior. It discharges into Winnipeg River with a fall of twenty-one and a quarter feet, at the foot of which the river turns abruptly westward and runs for three miles parallel with the lake shore, and separated from it by a narrow natural dam of rock, through which, at half a dozen points, the lake waters can be conducted by a flume of 100 yards in length. The estimated water power at this dam is 65,000 H. P., and between it and Lake Winnipeg the river has a fall of about 300 feet. The railway line follows this dam, and saw mills with cutting capacity of 60,000,000 feet B. M. per annum, working twelve hours daily, are in operation, for the supply of the prairie region as far west as Regina, nearly 500 miles, where it meets the timber and lumber from British Columbia. It is estimated that the timber supply from this point is good for thirty years, at double the present rate of consumption.

A flour mill, of 1,200 barrels daily capacity, has recently been erected at Keewatin. There was a surplus wheat crop in Manitoba last year exceeding ten millions of bushels, grown within an average haul of 250 miles of Keewatin. Thus there is already a possible wheat growth sufficient for half a dozen such mills. There are already forty-four elevators at way stations, with capacity of over two million bushels, and a still larger storage capacity for these on Lake Superior. The wheat elevators already extend more than 300 miles west of Winnipeg.

The Plain and Prairie Section.—The Rocky Mountains, which, from Santa Fe, in New Mexico, to Cheyenne, in Wyoming, run due north through Colorado on their most eastern projection, turn at Cheyenne (longitude 105 degrees west from Greenwich, or 28 degrees west from Washington), running northwest to the international boundary, and at Calgary (the Canadian Denver) strike the 115th meridian (38 degrees west from Washington), carrying the plain and prairie regions 10 degrees farther west than they are in Colorado. The width of the Canadian fertile belt west of the Red River is about the same as that of the prairie regions between Indiana and Colorado.

The prairie section, according to the Canadian Geological Survey reports, may be said to extend from the Red River on the 97th meridian west from Greenwich to Calgary, near the Rocky Mountains, on the 114th meridian, a distance of 800 miles, and from the 49th to the 54th degrees of north latitude. There are three distinct plateaux or "steppes," sloping from the Rocky Mountains northeasterly toward Lake Winnipeg and the Red River, having well-defined escarpments running northwesterly parallel with the range. The general slope from the foot hills of the Rockies averages about five feet per mile. The lowest of these plateaux averages about 800 feet above the sea, and embraces

* Address at the annual convention of the American Society of Civil Engineers, at Milwaukee, Wisconsin, June 28, 1888.—*From the Transactions of the Society.*

an extensive lake system nearly 14,000 miles in extent, the largest (Lake Winnipeg) covering 8,500 square miles. The total area, including the lakes, is 55,000 square miles. This interior basin, the lowest of the continent, generally known as the Red River valley, has the finest wheat land perhaps in the world. It is only fifty-two miles wide at the international boundary, and rises thence southward for about 200 miles, attaining an elevation nearly 1,000 feet above sea level.

The second steppe is about 250 miles wide at the 49th parallel, and 200 miles at the 54th, having an area of over 100,000 square miles, 71,000 square miles of which form the eastern portion of the great plains. Its average elevation is 1,600 feet above sea level.

The third steppe has an average elevation of 3,000 feet, being 4,000 feet at the foot hills and 2,000 feet at its eastern edge. Its area is 134,000 square miles, of which 115,000 are almost entirely devoid of forest. Its breadth on the 49th parallel is 465 miles.

The total area south of the 54th parallel is 280,000 square miles—about 180,000,000 of acres—of which, after allowing for swamps and lakes, mountains and barrens, by far the greater portion is arable.

The agricultural capabilities of the Canadian northwest are not, however, limited by the 54th parallel. That latitude is the northern boundary of the great plain and prairie region, which extends from Mexico through the United States to the Great Saskatchewan. Narrowing northward of the Winnipeg Lake basin, by the encroachment of the Laurentian formation on its eastern border, it extends as broken prairie and woodland to the shores of the Arctic Ocean, where its breadth is reduced to between 300 and 400 miles. Beyond the North Saskatchewan River, it loses its essentially prairie character, and from increasing moisture of climate becomes generally thickly covered with coniferous forest. From the best estimates which can be made in this imperfectly explored country, it is believed that it contains at least 120,000,000 acres of arable and pasture land north of the 54th parallel.

Thus there is in the Canadian northwest about 300,000,000 of acres of arable and pasture land, of which one-third or more may be capable of producing wheat of the finest quality known.

In a recent report of the Senate of Canada, it is stated that this northern forest-covered region embraces also the greatest fur-producing country in the world, supplying three-fourths of all the valuable furs sold in Leipsic and London, to the annual value of millions of dollars.

The climate of the eastern slope of the Rockies, for a belt of over 150 miles in width, is, as compared with the plains on the same latitude eastward, exceptionally mild in winter. A southwest wind, called the "Chinook," blowing at right angles to and over the Rockies, brings a thaw, removing snow and enabling cattle to feed out all the year round. At Canmore, in the Rockies, 4,200 feet above tide, cattle range out all winter. The remarkable warmth of a wind flowing for hundreds of miles over snow-covered mountains could not be accounted for by the proximity of the warm waters of the Pacific, and is explained by the alternate expansion and condensation of air flowing from the ocean level over the mountains, and descending thence to the plains below. As the moisture is evaporated, or the air expanded, in rising over the mountains, latent heat is absorbed, which is given out again by the condensation of the moisture or the compression of the air in descending to the plains below.

Another climatic feature peculiar to all high latitudes, which, according to Dr. Dawson, of the Canadian Geological Survey, is believed to account for the ripening of grain and vegetables in the Peace River region and north of the 60th parallel, is the greater length of the day and the greater amount of sunshine, the sun rising on June 21st at three hours and twelve minutes and setting at eight hours and fifty minutes.

The Bow River coal area is estimated to contain 330,000,000 of tons, and will be the chief source of supply for the prairie region and for many hundred miles of the railway, and an increasing source of traffic for the latter.

Natural gas has been discovered in boring for water near the foot hills, and is used for pumping at two of the company's stations.

The Mountain Region.—The Rockies, where crossed by the Canadian Pacific Railway, are separated from the Selkirks (one of the Gold ranges) by the Columbia River flowing north; and the Selkirks from the Gold Mountains, by the same river flowing south. Between the gold and coast ranges lies an undulating, bunch grass region known as "the dry zone," one of the finest grazing districts in Canada, but where crops require irrigation. This interior plateau has an average width of 100 miles, and an average elevation of 3,500 feet. There is an excessive rainfall on the coast, averaging about six feet per annum, falling chiefly between October and April, and a very great precipitation, particularly of snow, upon the Selkirks. The rain clouds from the Pacific being elevated by the Coast Range (with its higher peaks of 6,000 to 7,000 feet average, and some exceeding 9,000 feet), pass over the interior plateau, and precipitate their stores of rain or snow upon the Gold Mountains, and chiefly upon the highest of these, the Selkirks. The Rockies, therefore, although the loftiest of all the ranges, are the driest, and no snow sheds are required in them.

The agricultural resources of British Columbia are limited chiefly to this interior plateau and to the delta of the Fraser River. Lumber, fish, and minerals, in each of which her resources are unsurpassed, are the great features of the Pacific province, and these industries will furnish a local market for her agricultural products, her exports of which will, until irrigation is extended, be confined to horses and cattle. Through the Rockies, Selkirks and Gold Range, the railway has penetrated a hitherto inaccessible region and opened up a virgin forest, in which Douglas fir (Oregon pine) and cedar abound, with spruce and various pines. The first two are timbers of such value that they will bear rail transport to the northern Atlantic coast, where we have nothing to compare with them. Lumber is now exported from British Columbia to Japan, China, Australia, and South America. Since the commencement of the railway, saw mills have been established at eight different inland points in the mountains.

Coal and iron abound at tide water, as well as in the Rockies—the former the best in quality yet found on the Pacific coast, half a million of tons of which are now exported annually. Fifty millions of dollars in gold have been washed out in the province in the last thirty years, and quartz mining is now becoming a result of the railway. Silver is mined of sufficient richness to bear transport to a smelter at Omaha, a carriage of 1,750 miles. Smelting works and sampling mills are now being erected with the assistance of the provincial government.

Over 3,600 tons of canned salmon are exported, nearly all to Great Britain. The railway has opened an eastern market for this fish in its fresh state.

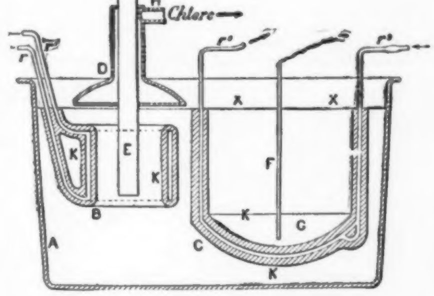
The railway has created a terminal city, which will soon surpass the older ones of Victoria and New Westminster, and has given an impetus to the coasting trade which reacts on itself; so that, with the wonderful natural resources of this province, the commercial success of the road in its freight traffic is already assured in the mountain region, where so little was expected at the first that security was required by the government for ten years' continuous operation of the road.

The Asiatic commerce is yet in its infancy, under temporary arrangements with chartered steamers. When the subsidized steamers now under construction for this trade are put on the route, both freight and passenger traffic may be expected to assume important proportions. Lumber and flour are principal articles of export; teas, silks, and curios, of import. Both New England and Canadian cotton manufactures have been exported to China by this route.

For local passenger traffic, which from the sparseness of population has, like the freight business, to be created, there is chiefly that of prospectors for minerals and timber, ranchmen, miners, and lumbermen, and settlers in the new towns which can be regarded as tributary to the road. Through traffic with all the Pacific coast is competed for, and tourist travel is specially cultivated. For this, the route through the mountain region offers exceptional attractions, and no expense has been spared to make the most of this class of traffic. The hotels at the National Park in the Rockies, and at the terminus, Vancouver, are, like all the company's equipment, modern and complete. The scenery is Alpine, the route the only glacier one in America, and comfortable hostelries have been established in the mountains for stop-over tourists or sportsmen wishing to hunt the Rocky Mountain goat, now about limited to these latitudes, the big horn, the grizzly and the mountain lion; or, farther north, the cariboo; and in the foot hills, deer, elk, and antelope; or to cast a fly in the trout streams and lakes of the mountain regions.

ELECTROLYSIS OF MELTED SALTS.

IN the electrolysis of substances brought to a liquid state by fusion, it is possible to obtain the products of the electrolysis separately by placing the two electrodes



in two distinct vessels. These latter should be made of a substance such that neither the melted mass nor the substances separated by electrolysis can attack it, so that the purity of such substances shall not be altered.

To this intent, Mr. L. Grabau, of Hanover, has devised a method in which the protecting covering of the cells is always formed of the same substances as the mass to be electrolyzed. He obtains this result by a cooling of the metallic sides of the cells. The melted mass hardens around the sides and deposits thereon in the form of a crust, thus forming the desired insulation.

The accompanying figure represents the apparatus as arranged for obtaining aluminum by the electrolysis of cryolite and the chlorides of sodium. The iron vessel, A, is heated until the mass with which it is filled up to the line, X X, becomes liquid. The annular and double-sided metallic vessel, B, is cooled by a circulation of water or air introduced into the interior space by means of the pipes, r r'.

A receiving vessel, C, also double-sided, serves for the reception of the separated liquid aluminum. Between the two sides of this vessel, the cooling current circulates through the pipes, $r_1 r_1$.

As a consequence of the cooling, the melted mass hardens around the sides of this vessel, and thus forms a non-conducting crust which cannot be altered by the melted mass nor by the chlorine or aluminum.

The funnel, D, is designed for the reception of the chlorine. As it is in nowise in contact with the melted mass, it may be of any material whatever, for example, of porcelain. The chlorine which develops at the positive electrode, E, ascends, and is collected in the funnel, D, while the aluminum separates upon the negative electrode, F, and accumulates at G.—*La Lumiere Electrique.*

THE NEW PRINTING-OUT PLATINUM PROCESS.

IN first estimating the depth of picture aimed at with the printing-out platinum method, regard must be had to the faintly green color of the double salt of iron and sodium which partly veils the platinum deposit. A little experience, however, will provide a guide in the matter and dispel anticipated difficulties on the score of under and over printing. As to a settled and uniform plan of printing, it is unlikely, except in some instances, that recourse will be had to the alternative methods of removing the print from the frame before it is deep enough, and allowing the total reduction of the salt to proceed in the dark, or of under-printing the picture and completing it with a weak solution of sodium carbonate. Both these plans would be useful in emergency, and their chief value lies in the fact that they constitute a reserve of force to be drawn upon in case of need. We may take it that the practice of printing right out and dissolving away the iron salt will prevail.

The quality of print so obtained does not, from individual experience, strike one as seriously rivaling the fine results associated with the older processes. The picture often seems wanting in delicacy of detail, and is coarse and fuzzy; while, paradoxically, the whites are not white, the blacks are not black. Chiefly has this been noticed to be the case in the real test of the capabilities of a platinum process—printing from landscape negatives. For portraits, however, of the head and shoulders type, the new method is by no means entirely unsuitable, the kind of picture obtained being softer and lighter in tone and contrast than that given with other platinum methods. To suggest that this lack of pluck in prints from landscape negatives arises from the inadequacy of the sizing operation possibly touches the real cause of the defect. In reference to the statement that the printing is completed in a third of the time occupied by albumenate of silver paper, the writer is unable to be in agreement; he has found it to be in the lower proportion of one to two. It should, however, be pointed out that the rapidity with which the image appears is largely dependent upon the quantity of moisture that the paper has been permitted to absorb before being placed in the frame. Simply breathing upon the sensitive surface, or allowing it to get damp by the agency of the atmosphere of a dwelling house, even in fairly humid weather, does not seem to suffice.

The paper should be placed in a light-tight box or drawer, at the bottom of which is a layer of blotting paper thoroughly wet, in actual contact with which, by a suitable device of cross pieces, the platinum paper should be prevented from falling, and should be so left for half an hour before use. If this is done, so that when placed in the frame the paper is fairly limp, the printing will proceed far more quickly than if the paper were only faintly damp, for a little reflection will show that in proportion to its absorption of moisture the sodium oxalate will influence the platinum salt and effect its reduction. Consideration of these phenomena will also point out that paper which has been once moistened and then allowed to dry parts with its sensitive properties, and is useless except for residue purposes. Further, the acid solution may with advantage be employed weaker than is recommended, and the removal of the iron salt allowed to proceed deliberately, for it is possible that a too rapid clearing, caused by too large a quantity of acid, although powerless to affect the stability of the metal, may cause the image to sink into its support, and thereby lose what vigor it previously possessed. The solution, again, should not be left on the picture for a greater length of time than is necessary to secure the immaculateness of the whites, and should not be employed for a second print or batch of prints.

As to the preliminary storage of the paper, the employment of the calcic chloride is not an absolute necessity if it is only desired to keep it a week or two before use, and a dry dark cupboard of an ordinary room be utilized. A better plan, perhaps, is to have a flat tin such as is recommended for keeping silver paper, as the new platinum paper is cut to standard sizes, a useful improvement upon the old practice of retailing it in large, unwieldy sheets. Complaint was recently made that the process we are considering is more costly to work than the development processes; probably the fact that artificial heat, development dishes, developing salt, platinum salt, rubber sheeting, etc., are not required was overlooked. A little elementary arithmetic will demonstrate the fallacy of the objection.

The printing-out platinotype will not improbably be largely employed where proof prints are hurriedly required, for it is easily worked, gives pleasing results, and is permanent, as the phrase is understood among photographers. Possibly the details of preparation are susceptible of improvement, and no doubt, as Captain Pizzighelli has placed the formula *coram populo*, we may expect the lead to be taken up commercially in this country. The direct reduction of platinum salts to metallic condition by the unaided action of light alone seems still beyond accomplishment, although a long line of illustrious chemists have experimented with that object. Let us hope success will reward the efforts of some at present unknown Hunt or Herschel, so that by-and-by platinum printing will be as free to all as silver printing is now, and patents, licenses, permits, and all the other extraordinary paraphernalia with which many think that, if asked, the high court of justice would play sad havoc, will join the dodo, the mastodon, and the Stuart dynasty.—*Thomas Bedding, in Br. Jour. of Photo.*

A CHAPTER FOR AMATEURS.

By C. BRANGWIN BARNES.

MOST professional photographers, in the course of their experience, discover or drop across various small aids or helps to this or that branch of the art. Many great things have, ere now, turned on trifles, and the object of this short paper will be to make known to the searcher after light in the amateur ranks of the "Art Science" some few trifles, which, small though they may seem to be so far as their importance in relation to the actual production of the photograph is concerned, may yet prove of great use to those who are compelled perforce to work under difficulties; whose studio is mostly the open air or the drawing room, and whose dark room has to be manufactured for the occasion.

Trifle the first. I have found that the orange paper used for packing plates, and which is mostly torn and thrown away when the box is opened, is very useful if saved. The pieces of this paper, if gummed or pasted together, come in very handy to cover over one side of a conservatory when in use as a studio; also to block the window or windows of any room that is being used temporarily as a changing or developing apartment, though of course new sheets of the same kind of paper may be used if preferred, the only difference being that the half sheets used for packing whole plates come considerably cheaper, and, being smaller in size, block

more light, owing to there being a greater number of joins.

Trifle the second. A good impromptu sink for developing in an ordinary room, and which can be carried with the other apparatus, consists of an ebonite dish 12 by 10, or larger; this will effectually catch any splashings or overflow of developer, and possibly save a blowing up for spoiling a table cover or staining a table. The best lamp for dark room work is one which is sold, I believe, by most dealers, and much resembles an ordinary paraffin lamp, the only difference being that the chimney is of ruby glass, and has a top to it to prevent the escape of white light; it gives a brilliant ruby light, which is at the same time perfectly safe for use with even the most rapid plates. I would never recommend an amateur to develop with anything but artificial light, unless he has a properly constructed dark room. No one knows the difficulty of improvising a dark room, or rather developing room, but those who have tried. Amateurs spoil more plates by fogging than from any other cause; therefore I would recommend that they always develop at night with a ruby lantern.

Imperfect washing, both of the negative and of the print, is a frequent source of failure, as many amateurs imagine that a few minutes' rinse under the tap is quite sufficient for the plate, and are often puzzled as to the cause of the stains which appear on the paper when printing, and of the damp and semi-greasy appearance and feel of the surface of the plate. Insufficient washing is the cause of this, and what is more, it must inevitably ruin the negative, as the soda left in continues its work for weeks and months, gradually eating away the whole of the image, and leaving a plate covered with white crystals in place of what was once a bright little negative. Over and over again amateurs have brought me their plates in this state to ask the reason of the failure. An hour's washing in running water is the least that can be given to insure permanence of the cliche, and double or treble this will do no harm. It is easy to tell when a negative is properly fixed, but it is much more difficult to judge the same with regard to a print; imperfect fixing inevitably means fading, and that at a very early date, whereas over-fixing has no such result. In point of fact, a print has to be very much over-fixed indeed to show any difference between it and one that has been timed to the second. Moral—Be sure not to underfix your prints if you wish them to stand; and when you are sure the hypo has thoroughly done its work, make sure the water does the same. Do not be content with an hour's washing now, but whenever it is possible give your prints all night in running water, after at least a dozen rapid changes—and in the morning give at least a dozen more. For mounting, use freshly made starch or gelatine. Avoid such preparations as are sold ready made by stationers, and which mostly contain an acid which, though it may preserve the mountant, will have the very reverse effect upon the photograph.

The vignette style of printing is of great utility to amateurs as well as to professionals, as bad or defective backgrounds, which are very common in amateur productions, can, by its aid, be obliterated. The best mode of vignetting such negatives is by the use of the commercial vignetting glasses; if used singly they are rarely found to be sufficiently opaque at the edges, and I would therefore recommend that, after adjusting the one best suited to the subject or to the outside of the pressure frame, another, with a trifle larger aperture, should be placed over it, which will give a better result.

Vignetting papers may be used in the same way, but the process of printing will be much slower than where the glasses are used; an alternative method, which may in some instances prove the best, is to cut a cardboard mask; this is especially useful where the ordinary pear-shaped opening will not block out any objectionable portion of the background or figure. To insure softness of gradation, tissue paper may be gummed over the aperture.

I would strongly advise all photographers, whether amateur or professional, to never omit the process of varnishing the negative, and that before a single print has been taken from it. Damp paper, or a damp atmosphere, will draw the silver into the gelatine film, and irretrievably ruin the plate; and no one knows how valuable that special plate may afterward become, though apparently of very little value at the time. Whenever a negative has been intensified it should be thoroughly washed, or it is sure to become worthless in a very short space of time.

In exposing, it behooves one to be careful as to the sequence in which the plates are exposed; even where a note book is in constant use, it sometimes happens that a plate is exposed on two different subjects merely through the operator exposing his plates out of order. As the slides are numbered, so should their contents be exposed, commencing with number one, and so on; not number five first because that slide was the first to come to hand. It is no more trouble to do the thing correctly, and there cannot be anything like the danger of making double exposures.—*Photo. News.*

THE HELMET OF PHILIP II.

THE HELMET OF PHILIP II.

Among the interesting historical and artistic objects still preserved in the Royal Armory, Madrid, Spain, are various articles that once belonged to the celebrated ruler Philip II. One of them is the helmet shown in our engraving, which was prepared from a photograph made from the relic itself. The helmet is complete in all its parts and remains in almost as good a condition as it was in those stirring old times when the monarch was accustomed to wear it. Our engraving is from *La Ilustracion Española.*

HAIRY PEOPLE.

UNDER the name of Pilosis, or Hirsutes, there have recently been exhibited at Paris two hairy individuals, a mother and son, who are interesting from several points of view.

The mother is a woman sixty-four years of age. Her name is Mahphorn. Her head is covered with long, fine, silky hair, quite similar to that of the spaniel. This hair is particularly abundant on the forehead and in the region of the eyebrows, and on the cheekbones. The ridge of the nose exhibits a heavy line, and the mustache is thick and is divided by a well marked line in the center of the upper lip. Upon the cheeks and chin the hair is very long and very abundant, especially in the places where the beard is usually developed in man. This poor old woman is blind. The son, Moung Phoset, like his mother, has hair on his face, but it is much more abundant and is coarser, and may be compared to the hair of a goat. His head is covered with long wool, which he gathers up at the extremity in the form of a chignon. The shoulders, neck, and breast likewise are covered with shaggy hair. The spine is covered with what looks like horsehair. Upon the limbs the hair is shorter and much finer, and is a kind of down about two inches in length. Neither the mother nor son is hairy on the hands and feet.

HAIRY MOTHER AND SON.

Moung Phoset was married in Burmah, and has had several children, among whom there was a girl who presented the same peculiarity as her father and grandfather. This girl, who was called Mahme, had reached the age of eighteen at the time of her death last year, just before her relatives started for Europe.

The history of these persons presents a few peculiarities that merit notice. Before the occupation of Burmah by the English in recent years, they lived at the court of King Theebault, where they were kept as curiosities among the dwarfs and buffoons; but, when the Burmans, through patriotism, burned the capital of their country so that they might not see it remain in the hands of the English, the hairy man and his family, frightened at the flames, at the fighting of the soldiers with the incendiaries, and at the noise of the cannons and mines by means of which the English were endeavoring to stop the progress of the fire, fled through the flames, the son carrying his blind old mother on his back and dragging along his wife and children. They took refuge in a forest near Amara Pourn, and it is here that an Italian officer, the chief of staff of King Theebault, who was sent to look for them, found them dying of hunger and fatigue and rescued them. It is he who is now exhibiting them in Europe.

These hairy persons were allowed, while at Mandalay, to go into the market and take any fruits and vegetables that they wanted, and the Burman peasants whose commodities had been selected were, it appears, extremely flattered, and considered this an honor and a favorable augury.

The existence of a hairy family at the court of Burmah has been known for a long time, and the persons composing it have been described several times by traders. Thus, Lord Crawford, who in 1824 was sent by the Governor of India to negotiate a treaty with the king, minutely describes and relates the curious history of a hairy man named Shwe Maong. He speaks of a child of the latter, a little girl then aged about two years, who likewise was covered with shaggy hair. This was Mahphorn, the old woman who was recently at Paris.

In 1855 some English officers who had been sent to Ava saw a hairy young woman, and gave a description of her. In their eyes it was one of the most curious things that they had met with in their travels. This young woman was this same Mahphorn.

In 1875, we gave a description of Shwe Maong, the hairy man, of his daughter Mahphorn, and of the latter's child, a young boy having the same peculiarity as his mother and grandfather. This boy was Moung Phoset, who was recently exhibited at Paris. He was the father of the girl Mahme, who died last year in Burmah. This girl, then, was an example of the hereditary transmission of hairiness to the fourth generation. Now, it is to be remarked that this transmission has occurred despite the influence of the blood of the wife, the action of which ought to have had a predominating tendency in consequence of an infinitely larger number of normal ancestors. In fact, it is not certain that the hairy men of Burmah are descendants of a race exhibiting this same peculiarity and formerly dwelling in the forests of Laos. From the standpoint of the study of heredity, it is well, then, in a few words to review the family history of each of the hairy persons of whom we have spoken.

The first, Shwe Maong, a buffoon at the court of the King of Burmah, was married in a novel sort of a way. A young woman of great beauty, a lady of honor to the queen, was accused of a crime against the religion of the country and condemned to die with most horrible tortures. On the day of the execution she was led with great ceremony to the cemetery where she was to be tortured. The punishment was about to begin when a horseman rode up with full speed bringing an order from the king to suspend the execution, and proposing to the young woman to become the wife of the hairy man, or otherwise to die. She preferred the strange marriage. The ceremony was accompanied with grotesque fetes, and the dwarfs, albinos, and fools of the king were the companions of the couple. From this union sprang seven children. The two first died young and exhibited nothing abnormal. The same was the case with the third, a boy, who lived. The fourth was hairy, and was, as we have said, the present Mahphorn. Of the remainder, two died very young, a boy and a girl, who seemed by the nature and arrangement of their hair to indicate that if they had lived they would have been shaggy at an adult age. Mahphorn married a Burman by whom she had several children; three of them—two boys and a girl—were hairy. Of these, the only one who reached an adult age was Moung Phoset.

Like his grandfather, Moung Phoset married one of the ladies of honor of the court, a voluntary proceeding on her part. From this marriage sprung one child, the hairy girl Mahme, of whom we have spoken. Such is, as regards heredity, the history of this strange family.

The two individuals who were exhibited at Paris have an abnormal dentition. They have no molar teeth, and in the upper jaw have only the two first incisors and two canines. The intermediate incisors are wanting. In the lower jaw they have four incisors and two canines. An analogous irregular dentition has several times been observed in people having an abnormal abundance of hair.

The examples of hairy people are quite numerous. Teratologists have cited a large number, and in the classification of monstrosities call the phenomenon *hypertrichopherosis*.

Some of these examples merit mention. A certain number of anthropologists now admit that prehistoric man of the tertiary epoch was smooth, not hairy, or scarcely any more so than a robust man of our day. But they admit that at a following period, at the beginning of the quaternary epoch, the human race was entirely hairy, and they base this affirmation on the discovery made a few years ago, at a prehistoric station, of a reindeer's horn upon which a quaternary artist had engraved the portrait of a woman covered with a long, thick fleece. At the end of this geological epoch man became smooth. This opinion has been criticised. It has been objected, in fact, that a single drawing representing a hairy person cannot suffice to prove that the entire race at that time had a like conformation. This woman may perhaps have been a freak analogous to the ones above described, and whom the artist of the epoch thought worthy of being transmitted to posterity by a drawing. However this may be, this hairy woman is the first one of which mention has been made in the history of the human species.

In the Bible, mention is made of a hairy man named Esau. In the *Melanges Academiques des Curieux de la Nature*, we find a description of a dog-man, whose birth, it is pretended, was accompanied with noise and flames. In the middle of the last century, the *Journal Etranger* gave a description of a hairy girl about seven years of age. Buffon speaks of a woman of the city of Bar, who, says he, "is entirely covered with tawny, tufted hair, from the clavicles to the extremities. In 1774, too, there was a Russian in Paris whose forehead and entire face were covered with black hair."

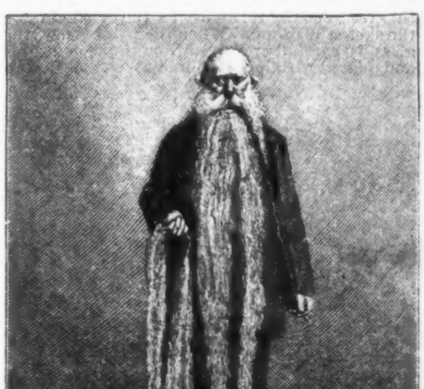
An Extraordinary Beard.—In nature, every class of facts is submitted to one general law, but this law is everywhere subject to exceptions. Aside from monstrosities, there are simple phenomena for which the common mother has shown herself prodigal of advantages. We have often had an opportunity of seeing astonishing champions of physical strength or human stature, but we believe that it is rarer to meet in our country with authentic capillary phenomena, of which no performer can proclaim himself to be the regenerator.

There is one man who is king of the genus, not on account of his hair, but of his beard, and that is Louis Coulon, now sixty-three years of age, who was born at Vandenesse, in the canton of Moulins-en-Gilbert (Nievre). He is an excellent iron founder, and has fixed his residence at Montlucon, where he is working at the Forey works, on the right bank of the Cher.

At the age of twelve years, when countenances vie with each other in white and rose, young Coulon was obliged to shave. His beard and mustaches grew so fast that the razor was conquered, and at fourteen years a beard 11¾ inches in length covered his breast. The little "old man" presented a singular figure among his comrades. Six years later, his beard had reached a yard in length and was growing most beautifully. It now measures 7¼ feet, and its owner has faith in the future. But the beard, which was formerly brown, and has been gray for nearly twenty years, will then be entirely white.

Naturally, there have been no want of propositions. English "cranks," showmen, and speculators have desired to enroll Mr. Coulon under their banner. Lord William offered him $2,000 for a trip, but the good man refused. Once only, in 1878, Coulon came to Paris, in order to consecrate his specialty officially. A thirty year old Englishman, the wearer of a wide and very square beard, disputed the prize with him; but this competing beard scarcely grazed the floor, while Coulon's was twice the length. In street attire, he winds it around his neck. Standing, Coulon is 5¼ feet in height, and his beard is therefore nearly twice longer than he is tall.

Facts analogous to the one that we have just presented to our readers have often been mentioned. The following may be read in the *Magasin Pittoresque* of 1839 (p. 236): "Rauber, a German nobleman, made himself celebrated in the sixteenth century by his great strength, his stature, and especially by his beard, which was of so extraordinary a length that it reached to his feet and extended up to his waist, so that he was obliged to wind it around a stick. He was so proud of it that he rarely rode in a carriage, but nearly always



LOUIS COULON AND HIS LONG BEARD.

went on foot in order to display it to more advantage, sometimes carrying it unfurled like a flag and allowing it to wave at the pleasure of the wind. When he died, it was cut into two parts and preserved as a treasure."—*La Nature.*

[Continued from SUPPLEMENT, No. 685, page 10948.]

YEAST: ITS MORPHOLOGY AND CULTURE.*

By A. GORDON SALAMON, A.R.S.M., F.I.C., F.C.S.

LECTURE IV—CONTINUED.

WE are now in a position to approach the question of pure yeast culture from an essentially scientific standpoint, which will be materially strengthened if we admit that fluctuations in flavor and quality of English beer are in the main attributable to the fact that we seldom, if ever, work upon the commercial scale with pure yeast. We have been in the habit of attempting to explain any observed defects by reference to various ingenious theories. Their value is not capable of better estimation than that of Hansen, who thus expresses his views upon the subject: "Much has been said and written about the degeneration of yeast in breweries. The foreign journals periodically give prominence to signed articles upon the subject, penned by the most eminent specialists. This degeneration is attributed to the influence of malt, of water, and of other factors. But upon a critical examination of the arguments presented in support of these hypotheses they are seen to resolve themselves into vague and obscure assumptions, which are not supported by any accurate experimental investigation whatever. What is the nature of this degeneration? How do we know that *S. cerevisiæ* can degenerate? The reply is simple—at present we have not determined what *S. cerevisiæ* is." It is but necessary duly to reflect upon the truth of these pregnant words in order to follow with greater interest the exposition which now follows of the method, devised by Hansen, of cultivating an undoubtedly pure crop of pitching yeast from a single and isolated cell.

The preliminary operations have to be undertaken in the laboratory, and before the cultivation can be commenced a few preparations are necessary. Some hopped and boiled wort thoroughly sterilized and free from suspended flocculent and precipitated matter, and having a gravity of about 13 or 14 per cent. Balling, is mixed with about 5 per cent. of pure gelatine. The latter is then melted, thoroughly mixed with the hopped wort, and sterilized. The gelatinized wort is next introduced, with all precautions against contamination, in quantity of about 10 c. c., into small sterilized assay flasks. These are kept covered with sterilized paper in a germ-free chamber, and are used as and when required. If they develop colonies of germs, or other visible growth, they are at once rejected. A series of sterilized Chamberland flasks are partially filled with sterilized distilled water. One or more of these may be required for use during the progress of the operations. A sample of yeast from which it is desired to produce the pure culture is placed in a small beaker, or flask, and well mixed with a sterilized glass rod. One of the Chamberland flasks containing the sterilized water is opened, and a few drops of the yeast deftly and rapidly introduced. The flask is then closed with all possible speed, and the yeast and water intermingled by agitation. One drop of the mixture is next placed upon a slide for examination under the microscope. The object thus far is to secure a sufficient but not too great a dilution of yeast, and it is in order to test this that the drop, extracted with a sterilized rod, is submitted to microscopic examination. It is considered satisfactory if 50 or 60, and not more, cells are discernible in a single field.

FIG. 31.—THE CHAMBERLAND FLASK.

The small terminal tube is plugged with cotton-wool or asbestos.

The gelatine wort in the assay flask is next gently melted over a low burning Bunsen flame, and when quite liquid the flask is plunged into a water bath maintained at a temperature of about 86° F., and never under any circumstances allowed to exceed 95° F., all windows being carefully closed, and every possible precaution being taken to render the access of fortuitous organisms a matter of impossibility. A piece of stout platinum wire about an inch long is held in sterilized forceps in a Bunsen flame till it glows red; it is then placed under a sterilized cover. When cold, it is again seized by the sterilized forceps, and dipped into the Chamberland flask, the contents of which are agitated previous to the opening of the flask. The wire having taken up a drop of the yeast in the water from the flask, is quickly withdrawn and dropped into the flask, on the water bath containing the gelatine wort. The vessel containing the latter is now taken out of the water bath, and well shaken in such a way as to avoid frothing.

A moisture cell is next employed. It is previously thoroughly cleansed and sterilized, and, to make assurance doubly sure, the cover glass is washed with a weak solution of alcohol in sterilized water. A glass spatula, previously sterilized in the flame, is dipped in the gelatine wort containing the yeast introduced by means of the platinum wire, and when sufficient of the mixture is adherent to the spatula, the latter is taken out, and by its means a film of the gelatine wort is spread as an even coating over one surface of the cover glass. Three or more cover glasses may be similarly treated, and when the wort is evenly spread, they are placed under sterilized covers and allowed to stand until by the agency of the added gelatine solidification is effected. A few drops of sterilized water are now placed in a sterilized moisture vessel. The top edges

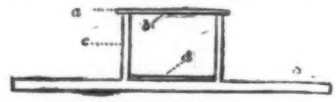


FIG. 32.—MOISTURE CELL. (Hansen.)

a. Cover glass. *b.* Film of gelatine wort. *c.* Small glass cylinder. *d.* Few drops of water. The whole apparatus is conveniently placed under the microscope.

are lightly rubbed with vaseline, and the cover glasses then pressed on to the top of the vaselined chamber in such a way that the film of wort is inclosed within the vessel, and is, by means of the vaseline coating, secured from communication of any kind whatever from without.

So far, the process consists in entrapping a few isolated single yeast cells in the gelatine wort, and one great difficulty in connection with the work, and one which can only be overcome with much practice, has next to be encountered. This is neither more nor less than the task of finding the cells which have been thus entrapped, and recording their position on the cover glass. To this end the moisture chamber is placed under the microscope, and the cover glass subjected to a searching examination with a quarter objective. Not more than one cell should be noticeable in each field, otherwise the particular cover glass should be discarded for the experiment. The cell having thus been isolated, its position on the cover glass is to be located. This is effected by means of a "cell marker" (sold by Klonne & Muller, Berlin). It is affixed by a screw to the microscope in place of the removed power, and slowly lowered down upon the cover glass. It is scarcely necessary to state that this should not in any way be moved. The marker leaves a black ring of ink upon the outer surface of the cover glass, and it is within this very small area that the entrapped cell is situated. A recognizable mark or number is then affixed in ink to the ring. The position of several cells on one cover glass may thus be recorded. They are identifiable by reference to a sketch plan taken at the time of the marking, upon which the number or mark attached to each cell is written, together with a sketch of the contour and size of the particular cell under notice, and a record of its position in the microscopic field. It may here be conveniently noted that immediately after use the spatula, vessels, forceps, platinum wire, cover glasses, etc., are plunged into a ten per cent solution of sulphuric acid, this being an essential precaution.

The moisture chambers, thus treated, are placed in an incubator maintained at a constant temperature of 77° F., and are left undisturbed for twenty-four hours. They are then removed and placed under the microscope. This time there is no difficulty in finding the respective cells by reference to the sketch diagram, and it is only necessary to use a low power, say one quarter. It will be found that each cell has developed into a minute colony, of which there should be but one within each ink ring. In order to be confident that the colony is derived from the single cell, it should be perfectly round. The presence of a stray cell, previously unnoticed, would assuredly spoil the circular appearance of the colony. An inspection of the various fields at this stage in the growth must carry conviction that no two colonies are sufficiently close to allow of coalescence on enlargement within the period allowed for further incubation. This examination serves to confirm the accuracy of the previous day's work, and any colonies not falling within the prescribed conditions would be immediately discarded and not further watched.

The moisture chambers, after having been thus examined, are returned to the incubator, and left untouched for a further period of forty-eight hours. They are then again examined under the microscope, in order to trace the development of the colonies, and to guard against coalescence. The colonies are now, however, visible with the naked eye. Indeed, they resemble the well known colonies obtained by the germ analysis of water by Koch's method. The position of each colony is now marked by covering it in white paint on the outside of the cover glass. The particular cell which has developed this colony is further recorded by reference to the original marking of the sketch diagram. When the paint is dry, the cover glass is carefully removed from the moisture chamber and placed within a sterilized cover. A Pasteur flask

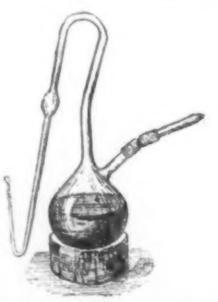


FIG. 33.—HANSEN'S MODIFICATION OF PASTEUR'S FLASK.

Flasks of various capacities are employed during the process of cultivation.

containing pure hopped sterilized cold wort is heated with a flame at the end from which the asbestos protrudes. While thus being heated the rubber at the other bend is warmed so as to allow of its easy release. It is quickly removed, and a colony, marked on the outside of the glass with paint, is dexterously pricked with a platinum needle previously sterilized. The rubber stopper of the Pasteur flask is then quickly removed, and the needle, containing some yeast cells derived from the marked colony, plunged into the flask. The rubber is then replaced, the flame removed from the asbestos, the contents of the flask well shaken, and the inoculation of the wort with yeast derived absolutely from one single cell is complete. The flask is now transferred to an incubator kept at the same temperature as before. The growth of the yeast is speedy; after the lapse of 48 hours a goodly crop of yeast will have developed. With every precaution against contamination the beer is then removed from the flask. Sterilized wort is caused to take its place, and it is again returned to the incubator for a further period of 24–48 hours. At the end of this time the crop has become considerable, and it is moreover in a vigorously thriving condition. If now the quality of the yeast is known, and it is not desired to subject it to an analytical examination for ascospores, it may be cultivated in the manner already indicated by changing the beer for wort from time to time, until sufficient is accumulated wherewith to charge the apparatus shortly to be described.

Should it be required to transport the samples of pure yeast thus obtained, Hansen has found that they may safely be sent through the post if wrapped in a double layer of blotting paper previously sterilized. Of course the introduction of the yeast into the blotting paper must be effected in a germ-free atmosphere, otherwise the risk of contamination is obvious. Of course, only small samples, intended for further growth, could be thus dispatched. In order to keep such cultures for years, so as to have the source of a pure stock to hand, it is advisable to introduce a very minute quantity into a sterilized Pasteur flask containing a ten per cent. solution of sterilized cane sugar. The fact that yeast may be thus preserved constitutes a very extraordinary problem in physiology, and has not, so far as I am aware, received a satisfactory explanation. The cultures may be preserved for some months if similarly introduced into Pasteur flasks containing sterilized wort.

If, however, it is desired to test the purity of the sample, it must be further subjected to the following treatment. Plaster of Paris is rubbed with water into a thick paste, then pressed into pyramidal blocks, the basal circumference of which has a diameter of about two inches. The cone is about two inches in height, and has a flat, smooth surface at the top about an inch in diameter. Once this has well set, it is dried and sterilized for a long time at a high temperature. Thus prepared, it is placed in a flat glass dish, which is filled to a depth of about a quarter of an inch with sterilized water. It is then loosely covered with a sterilized cover-vessel, in such a way that the advent of air is secured. This constitutes the apparatus required for ascospore formation. After the second addition of wort into the culture flask, and its growth, as above described, the beer is run off from the flask and a sterilized glass scalpel mixed in with the yeast. With this a layer of yeast about the size of a sixpence is smeared on to the top surface of the plaster of Paris. The top of the cover may conveniently hold four or five such flecks. The block is then covered as above described, and placed in an incubator to await the formation of ascospores, for which it is examined from time to time by removing a portion from the flecks on the cone, and rubbing into a drop of water placed on a glass slide, which is then looked at under a microscope in the usual way.

The rapidity of their formation will, as already pointed out, depend altogether upon the temperature of the incubator in which the block is placed and the particular species or variety of saccharomyces experimented with. Its identity can be established by recording its deportment under these conditions, and by subsequent reference to Hansen's tables, given on page 10899.

The purity of the sample having thus been placed beyond doubt, it is next grown in increasing bulk, with removal of the beer formed, and renewal of sterilized wort until it is removed to a flask similar to that shown in Fig. 34.

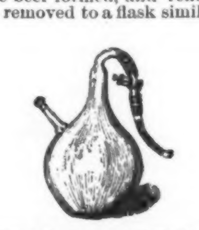


FIG. 34.—TRANSFER CULTURE FLASK. (Hansen.)

From this it is removed to the yeast apparatus shown in general elevation in Fig. 35, and in more detailed treatment in Fig. 36.

The apparatus is so simple in construction and in principle as to need but little explanation in addition to the illustrations. As Hansen says, it is an enlarged form of Pasteur flask with two necks. A is an air pump, actuated by machinery, and capable of supplying air, compressed to about ¼ atmosphere, to the reservoir, B. C is the miniature fermenting tun, and D the wort holder. The latter is thoroughly sterilized by means of superheated steam; this is displaced by means of the air obtained from the reservoir, B, and is sterilized by being drawn through the stuffing box, M, which is filled with cotton wool. Boiling hopped wort is introduced through the pipe, S, to which it is conveyed by the main pipe, U. This is cooled by circulating cold water through the hollow jacket, P, which lines the wort holder. The air required in the aeration of the wort is passed in through M. The fermenting vessel, C, is sterilized in a manner similar to D; G being the air filter of cotton wool through which its sterilization is effected.

The height of the liquid is noted on the glass tube, F. The carbonic acid gas disengaged during fermentation passes through the tube, *c*, and emerges from a water trough at *d*. The yeast and wort are mixed by means of the agitator, *b*. The yeast is introduced, and samples are taken by means of the small tube at J. When installed, the fermenting vessel is cased in wood. Fig. 36 shows this casing removed. Once the yeast has been added, the yeast may work for a year, or longer if de-

* Lectures before the Society of Arts, London, 1888. From the *Journal* of the Society.

sired, because some residual yeast is always left in the apparatus in order to ferment the fresh wort introduced. In working the apparatus, Hansen insists upon two points being kept in view. There must be a sufficiency of steam to effect a true sterilization, and during the withdrawal of yeast there should always be a good pressure of sterilized air. It is obvious that the apparatus may be of any convenient size, and may be adapted to the growth of any desired quantity of absolutely pure yeast.

From it the pure yeast is drawn as required. It must not be imagined that this process is any longer in the experimental stage. It has been worked for some long

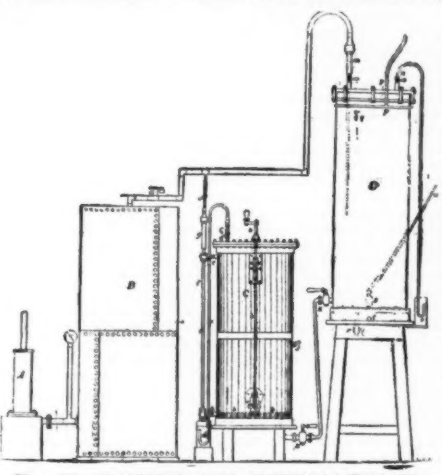


FIG. 35.—HANSEN AND KUHLE'S YEAST APPARATUS.

time now in several breweries, with the most brilliant results. In those establishments "returns" are unknown; beer can be bottled without leaving a sediment; special flavors can be secured and maintained; and the brewing operations are carried on with a regularity to which climatic change presents no obstacle. This, in itself, is sufficient to constitute the name of Hansen even equal in importance to that of Pasteur in the history of fermentation. Those who have studied the subject well know how great must be the merit of Hansen's work to have earned, as he has fairly done, in the eyes of European physiologists and chemists, so great and so coveted a distinction.

I have ventured to think that it would not be unworthy of the traditions of the Cantor bequest to place such contributions to industrial science before the brewers of this country, partly in the hope of stimulating them to activity in technological research, partly

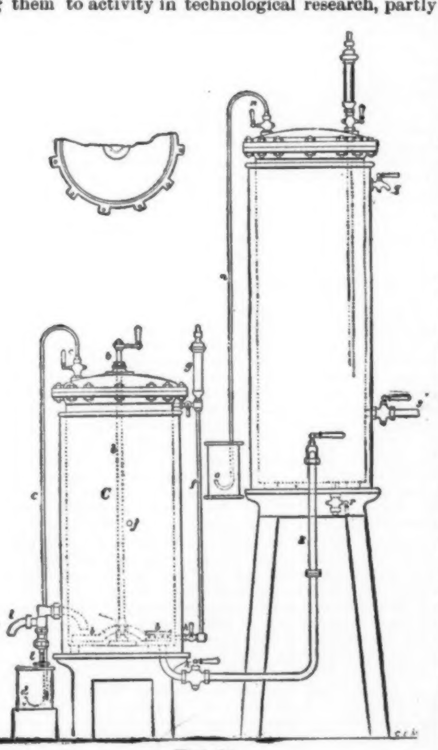


FIG. 36.

with the idea of bringing before them, and of recording in the *Journal* of this society, the researches and their applications, to which it has been my pleasing duty to direct attention. If I should not altogether have succeeded in these endeavors, I trust I may at least have been enabled to demonstrate that the morphological and physiological study of yeast are at once of deep philosophic interest and of the greatest commercial importance.

THE PREPARATION OF PHOSPHORESCENT STRONTIUM AND CALCIUM SULPHIDES.

By E. BECQUEREL

THE presence of very minute proportions of certain compounds in the preparation of the alkaline earthy sulphides is sufficient to modify the color, the intensity, and duration of the light emitted. Thus, on preparing calcium sulphide by the recalcination of a mixture of oyster shells previously calcined along with sulphur, the addition of 1 to 2 per cent. of manganese dioxide produces a mass having a fine yellow phosphorescence. Potassium persulphide, used in the same manner, causes the emission of a green light; with compounds of bismuth the light is blue and very persistent. Some of these additional substances, if used alone, produce no appreciable effect, and the joint presence of several of them is necessary.

LAUREL NUT OIL.

By DAVID HOOPER.

THE Alexandrian laurel (*Calophyllum Inophyllum*, L.) is distributed throughout India and Malaya, and is especially abundant on the western coast and in the native state of Travancore. The Hindostani name of the tree is Sultan Champa, the Tamil and Malayalam name is Punnai. Its thick green and glossy leaves resemble those of a laurel, but the tree is far removed from this family of plants, as it is really a Guttifer, belonging to the natural order Clusiaceæ. The fruit is about the size of a bantam's egg when ripe, and of a greenish yellow color; when dry it is brown or black and has a hard wrinkled surface. The seed, consisting of two white, closely united hemispherical cotyledons, loses in drying 30 per cent. of water, and the dried seed yields 68 per cent. of fixed oils. This oil is largely used for burning, and is occasionally used for making varnishes and soap. In medicine the oil is employed either alone or mixed with more powerful remedies as a liniment for rheumatism, and is applied to ringworm and various skin eruptions. The tariff valuation of laurel nuts in Travancore is Rs. 7 per cwt. and the oil Rs. 8, as against cocoa nut oil Rs. 14 per cwt. The value of the exports of laurel nut oil from Travancore during the past five years has been as follows: 1882–83, Rs. 74,314; 1883–84, Rs. 68,767; 1884–85, Rs. 48,997; 1885–86, Rs. 78,845; 1886–87, Rs. 57,148. In 1886–87, 63 cwt. was exported from Alleppey. Dr. Watt says that although this oil cannot compete with castor oil for industrial purposes in the Calcutta market, it fetches about four times the Calcutta price of castor oil in Burma.* In the Colonial and Indian Exhibition† held in London in 1886, this oil was shown from India, Ceylon, Straits Settlements, Queensland and Fiji. It is known out of India as domba, dilo or ndilo oil.

Laurel nut oil is greenish yellow, bitter and aromatic, but it has not been investigated chemically. Lepine found a sample to have the sp. gr. 0·942, and to solidify at +5°. During a recent visit to Travancore, I found a large trade being done in the nuts and oil of *Calophyllum Inophyllum* in the village of Neyoor, about sixteen miles from Cape Comorin, and here I purchased a sample of oil for examination. The oil was similar in appearance to some I expressed myself from some freshly dried almonds obtained from Neyoor. The following notes give the results of a chemical examination of the oil made with the assistance of Allen's "Commercial Organic Analysis."

The oil had a greenish yellow color, thick consistence, fragrant odor, and bitter taste. It commenced to congeal at the temperature of 19° C., and became quite solid at 16°, when it had a specific gravity of 0.9315.

The free acidity of the oil was found by shaking a weighed portion with alcohol and titrating the solution with normal alkali, using phenol-phthalein as an indicator. One hundred grammes of the oil required 1·89 grammes of caustic potash to neutralize the free acids.

The oil was saponified by boiling a weighed quantity for one hour with alcoholic potash, and the excess of alkali was determined by titration with normal hydrochloric acid. It was found that 100 grammes required 19·6 grammes of KHO to convert it into a soap; the saponification equivalent was therefore 285·6. The soap solution in alcohol, allowed to stand for a few hours, partially crystallized into lustrous white scales.

The volatile fatty acids obtained by Reichert's distillation process were very small in quantity. 2·412 grammes of oil required the equivalent of 0·1 c. c. of normal alkali for saturating the volatile acids, which is equal to 0·23 per cent. of KHO.

Two drops of sulphuric acid added to 20 drops of the oil gave a red coloration with orange streaks; after stirring the whole became an orange brown mixture. The oil shaken up with an equal volume of nitric acid, sp. gr. 1·4, formed a light reddish brown emulsion; after standing for an hour the oil separated with a rich mahogany brown color, and the lower acid liquor was red. Treating the oil according to Poutet's elaidin reaction, and working at a temperature of 20°, the mixture of oil and nitric oxide solution congealed in two and a half hours; after twenty-four hours it remained as a firm, butter-like solid of a dull lemon color, and yielding to the pressure of the finger.

5·045 grammes of the oil were, on November 7, exposed to the air in a watch glass under a bell jar, and weighed daily for one month. The increase in weight was just appreciable after the exposure; the weight on December 7 was 5·047. This quantity of oil heated in a water oven at 93° for eight hours gained 0·006 gramme only.

The insoluble fatty acids amounted to 90·85 per cent. They crystallized into radiating tufts of acicular crystals, having a melting point of 37·6°, and a specific gravity of 0·9237 (solid) at 16°, and of 0·8688 at 90°. Their mean combining weight, obtained by titrating the washed and dried acids with normal alkali and using phenol-phthalein as an indicator, was found to be 288·1. A lead soap of the fatty acids was made by decomposing the potash soap with a hot solution of plumbic acetate. After washing and drying, 1 gramme was weighed out and shaken up with ether; the oleate of lead, or soluble lead soap, weighed 0·44 gramme after the ether had been rapidly driven off. The lead soap, insoluble in ether, was decomposed, and the purified fatty acids had a melting point of 58°.

The oil agitated with 85 per cent. alcohol removed the green coloring matter and a sticky extract possessing the peculiar melilot-like odor and the bitter taste. This extract amounted to about 7 per cent.; it was almost entirely soluble in dilute alkalies with an orange color, precipitated unaltered on the addition of acid, and was perfectly soluble in ether and chloroform. The green mass was boiled with water and the filtered liquor evaporated had the odor of coumarin, but no rhombic crystals of coumarin could be observed in the slight residue when examined under a microscope. The alcoholic residue was crystalline, and contained some free fatty acids of the oil.

The conclusion arrived at from the examination of the laurel nut oil is that it cannot be regarded as a drying oil, nor altogether as non-drying, but must take up an intermediate position between the two. In endeavoring to classify this oil with those that have already been investigated, the task is not difficult. Most of the experiments exhibit in a very striking manner a strong relationship to those of the cotton-seed oil group. The saponification equivalent, the high melting point of the fatty acids and the free acids are very remarkable, and the sulphuric and nitric acid tests are particularly allied to those performed upon cotton-seed oil.—*Phar. Journal.*

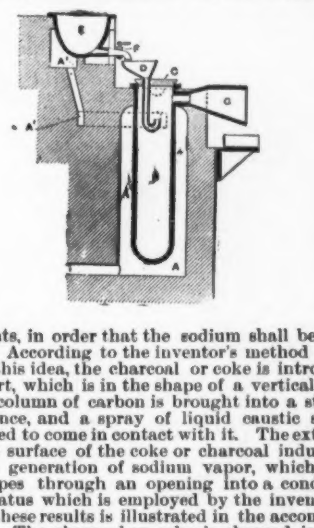
* "Guide to the Economic and Commercial Court," Calcutta, 1886.

† *Pharm. Journ.* [3], xvii., pp. 6, 142, 226.

MANUFACTURE OF SODIUM.

By C. NETTO, Dresden.

IN the process for extracting sodium by the intimate mixture of charcoal and soda, it is desirable to obtain the greatest possible surface of contact between the



two reagents, in order that the sodium shall be easily liberated. According to the inventor's method of carrying out this idea, the charcoal or coke is introduced into a retort, which is in the shape of a vertical cylinder. The column of carbon is brought into a state of incandescence, and a spray of liquid caustic soda is then allowed to come in contact with it. The extensive area of the surface of the coke or charcoal induces an immediate generation of sodium vapor, which afterward escapes through an opening into a condenser. The apparatus which is employed by the inventor for attaining these results is illustrated in the accompanying figure. The charcoal or coke is charged into the retort, B, which is suspended in the furnace, A. A pipe and funnel, D, penetrate through the cover, C, and allow the ingress of the molten soda. The soda is liquefied in the vessel, E, which is built in the upper furnace, A'. The heat is supplied to the latter by the gaseous products from the furnace, A. The sodium vapor escapes through the opening, G, into the condenser. Any caustic soda which may happen to have been unaffected by the charcoal collects at the bottom of the retort, together with any carbonate of soda which may be formed by the reaction. These deposits are removed after a time, and are regenerated for further use. No air is allowed to enter the retort, so that the risk of an explosion is obviated. Two claims are made for the process and for the apparatus, in which retort is without grates, to prevent the access of air.

FLETCHER'S COMPRESSED OXYGEN FURNACE.

THE use of oxygen with coal gas in a laboratory furnace has, up to the present, been attended with serious difficulties, owing to the intensely local nature of the heat obtained, and the consequent perforation and destruction of crucibles and other vessels.

In this furnace, diffusion of the heat is secured by using a fine jet of Brin's compressed oxygen directed centrally into one end of a tube a quarter of an inch in bore, open at both ends, the oxygen jet acting as an injector, and drawing with it from four to eight times its bulk of air, the proportion depending on the size of the

oxygen jet. This tube, containing the mixture of oxygen and air, is used as the central part of an ordinary blow-pipe of heavy cast iron, which is placed close up against the burner opening of one of Fletcher's ordinary injector furnaces, lined with a specially refractory material.

The power of the furnace depends entirely on the quantity of oxygen and gas supplied, and can be adjusted to any power from a dull red, which can be maintained for many hours steadily, without attention, to a heat which will "drop" the most refractory crucible in less than five minutes from the time the gas is lighted.

When working at moderate temperatures, the furnace is sufficiently quiet to admit of its use on a lecture table, but at its highest power the noise is considerable.

There is no difficulty in adapting the burner to other forms of furnace, provided it is found possible to produce satisfactory casings to withstand the heat; those

made for the crucible furnace stand, as a rule, exceedingly well; but with alterations in form great difficulties are introduced, more especially with muffles, which, as at present made, will not stand any sudden heat, nor will they hold their shape at any temperature approaching whiteness. The burner alone will be useful in heating many substances in the open, but, owing to the broad and diffused flame, it is of little practical value for blow-pipe work.

The special advantages of the apparatus are that it is entirely self-acting, requires no attendance, and that it greatly increases the range of temperatures which can be obtained by any simple apparatus. The largest size at present made takes crucibles not exceeding three inches high.—*Nature.*

THE ACTION OF MEDICINE.

By E. M. McPHERON, M.D.

A KNOWLEDGE of the *modus operandi* of medicine when introduced into the organism is the most essential element of therapeutics. In order that the physician may make a rational application of remedial agents for the cure of disease or alleviation of pain, it is necessary that he be possessed of a knowledge, to some degree, of the method of action, when introduced into the body, of the agents which he is using; and the more he knows of such action, the more rational will be their application and the more successful will be his practice.

We will admit that the manner of action of many therapeutic agents in the organism is obscure, and in some instances impossible of detection and apparently inconsistent, as is instanced in the action of carbo-veg. It is an admitted fact, among those who have specially experimented with this agent, that it is incapable of absorption when introduced into the organism in the natural way, regardless of the amount introduced or the high degree of subdivision; still it is a well-known fact that this is an agent used extensively by the best physicians of our school and of other schools to overcome passive hemorrhagic conditions of organs of the body remote from the alimentary canal, prominent among which is the uterus.

In Scudder's "Diseases of Women," page 461, in treating of menorrhagia, the author says: "In passive uterine hemorrhage I have placed more dependence upon carbo-veg., 2d dec. trituration, than upon any other remedy, though of course it is not adapted to all cases. I give it in grain doses, every one to four hours, and usually follow it with the tincture of cuprum as a blood maker."

There are other agents which are almost insoluble, such as subnitrate of bismuth, sulphur, calomel, etc., but it is probable that these substances undergo decomposition in some of the fluids of the body, being rendered partially soluble thereby. According to Headland, calomel is rendered soluble, to some degree, by the action of the biliary secretion upon it; and, aside from this, that it is absolutely insoluble and incapable of absorption in the animal organism; but no experimenter has ever discovered a solvent for carbo-veg., hence we cannot account for its probable action in such a manner. A number of propositions, as formulated by Headland, will serve as a basis of what we shall say upon this subject.

The first proposition affirms that "the great majority of medicines must obtain entry into the blood or internal fluids of the body before their action can be manifested;" that mechanical contact with the parieties of the stomach is not sufficient, in general, to produce a systemic effect. The only exceptions to this rule may be cited those agents having a mere local action on the mucous membrane, simple contact being necessary, such as irritant emetics, irritant cathartics, superficial stimulants, sedatives, astringents, etc. Medicines do not have to enter the blood directly to reach distant parts. For example, when chloroform, cocaine, aconite, or opium—fluid preparations—are rubbed upon the skin or mucous membranes, they are directly absorbed by the intestinal fluids, acting upon the minute nervous ramifications in the superficial tissues before being taken into the blood. Such is the action of belladonna, atropine, and eserine when dropped into the eye of an animal. They are directly absorbed by the intestinal fluids of the cornea, sclerotics, and iris, and exert their action upon the tissues of the parts before entry into the blood. From the foregoing, it might be inferred that these medicines may never reach the blood, but this is pretty conclusively disproved by the fact that a drop of hydrocyanic acid, dropped into the eye of a dog, has been known to produce speedy death; and the more conclusive does this seem to be, since it has been positively demonstrated that nervous connection alone is wholly insufficient for the transmission of the action of medicines in the organism. To substantiate our proposition, we will make the following affirmations:

1st. That a medicine introduced into the organism elsewhere acts in the same way as when introduced into the stomach. Many proofs of this may be shown. Tartar emetic, ipecac, apomorphia, etc., injected into the tissues, will produce emesis, and even more rapidly than when taken into the stomach. A moistened leaf of tobacco, placed over the radial artery at the wrist, has been known to provoke vomiting. Sulphate of magnesia, when injected into the veins, will act on the bowels; and, in like manner, rhubarb or senna, injected into the thorax, will produce purging. Croton oil, liquid jalap, rhubarb or gamboge, rubbed upon the abdomen sufficiently long, will produce purging. Injections of nux are rapidly followed by toxic symptoms, similar to those following its internal administration, etc.

2d. The continuity of nerve is not necessary for the propagation of remedial effects; but vascular connection is necessary. This affirmation is proved by the experiments of Magendie. He introduced some urari poison into the limb of a dog, which was only connected to the trunk by means of quills uniting the divided ends to the main vessels. It rapidly took effect. Having divided all the nerves and lymphatics in the intestine of another dog, he introduced into it some nux vom. beyond the division. It quickly acted, and must have done so through the vessels. Sir B. Brodie cut all the nerves of the anterior extremity of a rabbit near the axilla, and introduced urari into the foot. It quickly acted. Sufficiently tight ligaturing of an extremity will prevent systemic toxic influence. Sir B. Brodie also experimented upon parts connected with the body only by nerve continuity carefully dissected out, and found nervous structure incapable of transmitting toxic action. Other experimenters, as Emmer, Robinson, etc., have confirmed this latter experiment with the most violent of poisons, prominent among which is prussic acid.

3d. The circulation of the blood is sufficiently quick to account even for the operation of those poisons which act most rapidly by influencing the nerve centers. Experiments have proved that a substance will traverse the whole circulation of a dog in nine seconds, and of a horse in twenty seconds, while in an adult man the time required is 65·76 seconds. This is sufficient to account for the mode of action of that most rapid and fatal of all poisons, viz., prussic acid. Besides, if a medicine acted by nervous transmission, it would act as soon as it touched the stomach or injected into the tissues. Animals will sometimes live for thirty minutes after being poisoned with cyanide of potassium.

4th. The great majority of medicines have been detected in the blood or the secretions formed from it. We have proved that poisons act when introduced into the organism at any point; that vascular connection is required for this action; that nervous connection is wholly insufficient; and that the circulation is sufficiently rapid to account for the action of the most rapid of poisons. Now, if our last affirmation can be proved, we will have carried our first proposition close to certainty. In 1847, Mr. Allen detected daturia in the urine of a man poisoned by stramonium. In 1824, M. Runge discovered the principles of henbane and belladonna in urine. Kletzinsky finds that if the throat be gargled for five minutes with a solution of any soluble mineral salt, its presence may be detected in the urine next evacuated. Chloroform has often been detected in the blood. Indigo, logwood, and many other substances have been found in the urine. Alcohol, prussic acid, etc., have been found in the blood of persons dying shortly after the ingestion of such substances. Sulphur has been detected in the perspiration, and mercury in the saliva of persons who have taken these substances. Arsenic, mercury, antimony, and other poisons may be detected in various parts of the body after death. Blood passing from the veins of a poisoned animal into the circulation of another animal causes its death. Flesh of poisoned animals is poisonous to those who eat it.

Thus, from these four considerations, we seem to be justified in concluding that a medicine must pass from the stomach into the blood before its distinct action can be manifested.

Some exceptions may be taken to this as follows: Suppose a cantharides plaster be applied to the surface of the chest, in a case of pericarditis, so as to blister the skin, absorption of the fluid in the pericardium may follow the application. In our proposition, we have reference to the special or peculiar action of a remedy. In this last case, any irritant would have done the same thing; so we cannot attribute the absorption to the special or peculiar action of the cantharides.

Some medicines have a marked local action on the mucous surfaces of the stomach and bowels. These may, without entry into the blood, produce an effect in parts of the organisms remote from the alimentary canal, by counter-irritation or revulsion. Thus we use irritant emetics or cathartics to arrest incipient inflammatory action, as in disease of the eye, ear, brain, etc. This action may be carried to that extent that it will produce death, as when powerful corrosive poisons are taken into the stomach; but, as before stated, this is not the special action of such agents, and does not invalidate our proposition.

Our second proposition is as follows: That the great majority of medicines are capable of solution in the gastric or intestinal secretions, and pass without material change, by a process of absorption, through the coats of the stomach and intestines, to enter the capillaries of the portal system of veins.

In order that the substances may gain entrance into the blood after ingestion, it is necessary that they pass through the coats of the stomach and intestines, and also penetrate the capillary coat.

This process is called absorption or endosmosis. The basement membrane, supporting all mucous membranes, is a structureless or homogeneous tissue; hence no substance can pass through this membrane except it be in a state of solution. Outside the mucous membrane, and in juxtaposition to it, is a network of very small veins with thin walls, and the same forces which cause the fluids to penetrate the mucous membrane also cause the same to pass through the walls of the capillaries and smaller veins.

We will consider this subject in three parts: 1st. What is the nature and function of the gastric juice? 2d. The laws of the process of endosmosis. 3d. The mode by which medicines are reduced to a state of solution.

Stomach digestion is pretty thoroughly understood at the present time. We will not attempt a treatise on gastric digestion, but will recount some of the more salient points having a relation to the thought we are pressing. Whenever a substance is introduced into the stomach there is a copious outpouring of the gastric juice, the secretion of the glandular apparatus of the mucous membrane of the stomach. The amount of this secretion depends, to some extent, on the kind and mode of introduction of substances introduced into the stomach. This secretion is highly acid, owing to its admixture with hydrochloric or lactic acid, and contains, as one of its essential constituents, an organic principle known as pepsine, or *gasterase.* The result of this secretion is the solution of those substances soluble in a fluid of this chemical nature, reducing them to a thin, watery pulp capable of being absorbed. Medicinal substances which are soluble in the gastric secretion are directly taken up by the coats of the stomach and passed into the blood, and from thence to that part or parts of the organism upon which they have an affinity for action; while those that are insoluble in this *menstruum* are passed on into the intestines; and if non-soluble in the intestinal fluid, are excreted in the form in which they were ingested, without producing any special or peculiar effect on any part of the organism remote from the alimentary canal. The intestinal and buccal fluids are alkaline in reaction, from the presence of carbonate of soda, and the gastric juice, as before stated, is acid; so that if any substance is insoluble in the one, it will likely be reduced to solution in the other. We need say nothing about the possibility of stomachic and intestinal absorption, as that fact is well established. The mucous membrane of the small intestines is covered by small projections, called villi, the function of which is the absorption of fatty substances which have been taken into the alimentary canal and reduced to a state of emulsion by the action of the pancreatic juice. According to Bernard, and others, the villi of the small intestines never absorb medicinal substances not of an oily or fatty nature, but that substances reduced to solution in the intestines are absorbed directly into the blood. Magendie demonstrated that a ligature placed around the thoracic duct will not affect or prevent the toxic influence of poisons introduced into the body. Experiments have been made to discover the presence of medicinal substances in the chyle ducts, but so far they have failed; so that we may reasonably conclude that medicines are not absorbed in this way.

The process by which fluids pass and repass through animal membranes is known as *endosmosis* and *exosmosis,* according as the current tends inward or outward. There are fluids on both sides of the membrane, so the following laws regulate the direction of its passage: 1st. The densities of the liquids. The lighter of the two tends to pass through the heavier, other things being equal. 2d. Their attraction for the intervening membrane. The one passing the more rapidly having the greater affinity for the membrane. 3d. The affinity of the fluids for each other. That one passing through more rapidly which is readily taken up and dissolved by that on the opposite side. 4th. The motion of the fluid on one side prevents the passage from the other. 5th. Pressure of the fluid on one side tends to hasten its passage to the other.

All soluble mineral substances are absorbed in the stomach and intestines. Precipitations and re-solutions occur between some of the minerals and the salts of the digestive fluids, but in no case is there absolute fixation of the foreign agent, from its chemical incompatibility with animal fluids. Mineral acids, salts of metals, alum, and the tannic principles of vegetables must be precipitated to some extent by the albumen and pepsine of the gastric juice, but are redissolved by the intestinal fluids, which are alkaline. The inorganic alkaline salts are not precipitated by any of the animal fluids, but tend to render them more solvent. Some have thought that the soluble salts of mercury, silver, and lead might be precipitated by the chloride of soda in the gastric juice; but this can hardly be, since this fluid only contains 2·5 per cent. of the salt; besides, a small dose is more efficient than a large one of these salts, which could not be if precipitation took place. The intestinal secretions contain alkaline carbonates, which would precipitate the oxides of many metals, from solution of their salts; but if the metallic salt is not absorbed in the stomach, it descends into the intestines as an albuminate, and, instead of being precipitated, is rendered more soluble by the alkaline secretion.

Thus it appears that all soluble substances, organic or inorganic, given either as food or medicine, and in whatever way rendered soluble, whether by acids or alkalies or by digestion, are absorbed by the stomach or intestines. All, except fatty matters, pass directly into the blood, through the portal vein into the liver, to the heart, and thence to the various parts of the body. They are mostly absorbed without change. Some, however, may be absorbed as an albuminate. The stomach acid is too weak to displace mineral acids. It does displace a few vegetable acids, prominent among which is prussic acid. When cyanide of potassium is administered, the acid of the gastric juice, being a stonger base than that of hydrocyanic acid, immediately displaces the latter, setting free the prussic acid in the stomach; hence the rapidity of its action.—*Amer. Med. Jour.*

ON THE USE OF STEAM IN SPECTRUM ANALYSIS.

By JOHN TROWBRIDGE and W. C. SABINE.

AMONG the difficulties with which the investigator in spectrum analysis must contend is that of obtaining a source of light which is free from constituents other than those which are under examination, and at the same time sufficiently powerful to enable him to photograph the spectra of the latter. The voltaic arc gives a sufficiently strong light to enable one to photograph throughout the visible spectrum; the electric carbons, however, are full of impurities, and it is difficult to interpret the spectra obtained by these means. Moreover, it is not easy to employ the arc spectrum for researches in the ultra-violet portion of the spectrum. On the other hand, the spark from a Ruhmkorff coil taken between terminals of metals, the spectrum of which we wish to examine, gives us in general spectra comparatively free from impurities, but its light is very feeble compared with that of the electric arc, and even when the spark is obtained by means of a powerful coil which is excited by an alternating dynamo machine an hour is necessary to obtain with a concave grating of 21 feet radius of curvature, on the most sensitive dry plate, a photograph of the ultra-violet spectra of copper at the wave length 2100.

It becomes an important question then to ascertain whether the time of exposure of the sensitive plate can be shortened by any process; for the outlay in obtaining one photograph in the ultra-violet by the means hitherto at our command is very large, involving as we have said the running of an engine of at least two horse power for an hour. In our experiments with a jet of steam we find that the time of exposure of the sensitive plate can be shortened to at least one-third.

We were led to employ steam for the purpose of obtaining the spectra of oxygen and hydrogen with a more powerful electrical excitation than is possible in Geissler tubes. During the winter of 1886, when engaged upon the subject of oxygen in the sun, one of us in connection with Mr. C. C. Hutchins tried to obtain a powerful electric spark in an atmosphere of steam, but the experiments were unsatisfactory. The difficulties were chiefly in the way of proper insulation. Experiments showed that no containing vessel could be employed for the sides of the vessel conducting the electricity from one terminal of the Ruhmkorff coil to the other. No spark could be obtained, and the experiments were abandoned. During the present winter the experiments were renewed. The containing vessel was abandoned, and the jet of steam was allowed to

impinge directly upon the spark. No effect could be perceived when there were no condensers in the secondary circuit, and with the introduction of small condensers the effect was not marked; but when the number of Leyden jar condensers was increased to four, the effect of the jet of steam upon the electric spark was surprising. Its light immediately became comparable with that of the electric arc, enabling us to see the metallic spectra with the naked eye upon the ground glass of the photographic camera without the use of an eye piece. The chamber in which the spark and steam jet were placed became rosy red from the hydrogen arising from the dissociation of the steam. The hydrogen and oxygen lines in the air spectra became very much strengthened, a continuous spectrum showed itself in the neighborhood of the C line and also in the yellow, and a photograph of the air line and metallic line of the terminals employed could be taken in a third of the time which was necessary when the steam jet was not employed.

The apparatus consists merely of a tin box which is placed opposite the slit of the spectroscope. Steam enters at one side and is blown across the terminals of the Ruhmkorff coil, which are placed in the box opposite the slit; an outlet on the side opposite from the place of entrance of the steam allows the waste steam to escape into the outer air.

The change of color of the spark is undoubtedly due to hydrogen. The light filling the box above referred to is decidedly red, and the hydrogen line, C, flashes out with great brilliancy in the midst of a continuous band of red in the spectrum. The metallic line from the terminals is greatly strengthened. The light from iron terminals is especially brilliant. Without the steam the spark between iron terminals seemed to consist of a single line of discharge. When the steam was turned on, a great bundle of sparks appeared in the midst of a flaring light, and the noise of the spark was greatly increased. This effect can undoubtedly be traced to increased conduction of the air space between the terminals of the Ruhmkorff coil.

The appearance of the spectra led us to examine the question of the spectrum of the aurora borealis and its connection with that of aqueous vapor. We believe that the theory that the shifting nature of the northern lights may be due to electrical discharges following strata of air more or less laden with aqueous vapor has been advocated. The appearance of the spectra of the electric spark in steam certainly leads one at first to favor this hypothesis. We have spoken of the marked brilliancy of the hydrogen line and of a continuous red band near this line. The continuous spectrum in the yellow is no less prominent. The observations which have been made on the northern lights do not enable one to make exact comparisons. The lines given by different observers, however, do not appear to coincide with the prominent lines and bands observed in the air spectrum heightened by steam.

Other observers, among them Professors Liveing and Dewar, have employed steam to obtain steam lines, but we have been unable to find any reference to the remarkable economy in time and in waste of apparatus which results in the use of a jet of steam in spectrum analysis, when the spark method of obtaining the spectra of metals is employed.—*Amer. Jour. of Science.*

[NATURE.]

N. M. PRJEVALSKY.

A TELEGRAM from Vyernyi—one of those small Russian towns which have grown of late in the outspurs of the Tian-Shan Mountains—announces the death of Prjevalsky, the bold and indefatigable explorer of the wildernesses of Central Asia. In September last, immediately after having terminated the work which embodies the results of his fourth great journey to Central Asia, he started on a new journey, the fifth, thus prosecuting again what has been the aim of his life during the last twelve years—that of reaching Lhassa in Tibet, and opening to science the lofty plateaus and highlands which separate East Turkestan from India. This time he proposed to start from Russian Turkestan, and his expedition had to be equipped at Vyernyi, on the north of Lake Issyk-kul. He arrived at Tashkend in October, and had left it on October 13 (old style ?) on his way to Vyernyi, but he seems not to have reached that town, and must have died on the route, as far as we can judge from the telegram. The new expedition, which promised to be even richer in scientific results than all those which preceded it, was thus prevented. But Prjevalsky has left, in the traveling companions who remained so true to him in his adventurous journeys, a staff of young men who will certainly continue his work, and sooner or later open to science the dreary highlands which have baffled so many a bold explorer.

N. M. Prjevalsky was only in his fiftieth year, and usually enjoyed robust health. He belonged to a noble family, and was born in 1839, in the government of Smolensk. At the age of seven he lost his father. During the early years of his life he was trained by his mother (whose maiden name was Karetnikoff), a teacher who stayed in their house, and a brother of his mother. He soon became an eager hunter, and spent all his holidays in hunting in the Smolensk forests with his uncle. This taste he retained during the rest of his life, and he frankly admitted that his first journeys in Central Asia were due as much to his passionate longing for rich hunting grounds as to his desire to conquer for science the unknown wildernesses. Scientific interest developed more and more during and after his first Central Asian journey, when, accompanied only by three men, and possessing ridiculously small pecuniary means, he crossed the Gobi, reached Pekin, and, pushing westward and southwestward from the Chinese capital, explored the Ordos and the Ala-shan, and reached the Kuku-nor as well as the upper parts of the Yang-tse-kiang—the mysterious Dy-tchu of the Chinese geographers. And yet, when we saw him on his return from that wonderful journey, his eyes glittered and his face radiated chiefly when he was telling us of his achievements as a hunter and a discoverer of the ancestors of our domesticated animals—much more than when he was talking of his geographical discoveries, about which he always was, in fact, remarkably modest.

He received his first school education in the Smolensk Gymnasium, but he soon left this institution, and entered in 1855 an infantry regiment as a subaltern. Next year he became an officer, and five years later he entered the Academy of the General Staff. His love for geographical exploration had been to some extent developed by that time, and the dissertation he wrote on leaving the Academy was upon the Amur region, which was much spoken of in Russia. But he had not yet the means of satisfying his desire for travel, and he was compelled to return to his regiment and take part in the suppression of the Polish insurrection. He soon withdrew from active military service, and accepted the position of teacher of geography at a Warsaw Gymnasium, devoting his leisure hours to studies in natural history. It was only in 1867 that he was admitted into the General Staff and sent to Irkutsk, whence he immediately started for the exploration of the very little known highlands on the banks of the Usuri—the great southern tributary of the Amur. Here he found a wide field for exploration and hunting, and wrote a book on the Usuri region (published in 1869), partly of an ethnographical character. The Geographical Society awarded him for this book only a small silver medal; and, when Prjevalsky applied for means to enable him to explore Southern Mongolia, the society was anything but generous in its response. Had it not been for his own small economies—he always lived a very simple life—and for the help he received from the then Russian Ambassador at Pekin (M. Vlangalli), himself an explorer of Mongolia, Prjevalsky could hardly have started on that remarkable journey. When he began the exploration of the land of the Tangutes, he possessed only 178 rubles (about £25); and when he reached, with his three companions, the sources of the Yang-tse kiang, after having crossed the province of Han-su, the Tsaidam, and part of Northern Tibet, he had only ten rubles left, and his camels were quite exhausted. The whole expedition, which lasted thirty-four months (November, 1870, to September, 1873), had cost only 6,000 rubles; yet this undoubtedly was the most remarkable journey that had been made in Asia in the nineteenth century. Prjevalsky proved that, for resolute and enduring men, traveling on the Central Asian plateaus was much easier than had been supposed. He twice crossed the Gobi, reached the Kuku-nor, penetrated as far southwest as the spot where the Yang-tse-kiang rises from the confluence of the Mur-usu and the Nantchitai River, and returned with exceedingly rich zoological and botanical collections, after having traveled no less than 7,320 miles across formerly quite unknown deserts and highlands. The work in which he embodied the results of that wonderful journey, "Mongolia and the Land of the Tangutes," was immediately translated into all civilized languages. The Russian Geographical Society hastened to present him with its great Constantine medal, and most of the geographical societies all over Europe congratulated him on his discoveries, and awarded him medals, honorary diplomas, and the like.

Prjevalsky, in the meantime, was trying to find the means for continuing his explorations; but it was only in 1876 that he succeeded in obtaining from the Ministry of War the 25,000 rubles which were necessary to enable him to push as far as Lob-nor. His aim was not only to rediscover the basin of the Tarim and the great lake of East Turkestan, which had not been visited by any European from the time of Marco Polo; he desired to cross East Turkestan and the northern plateaus of Tibet, and to reach Lhassa. This time he started from Turkestan, and, following the upper part of the Ili River (the Kunges), he reached Kurla in East Turkestan, whence he crossed the desert and reached the Lob-nor. The great lake was thus rediscovered, But it was impossible to reach Lhassa by this route, and Prjevalsky returned to Kulja, and thence to the Russian post Zaisan. His aim was to penetrate into Tibet *via* Hami, the Tsaidam, and the sources of the Blue River. So he started again, from Zaisan to Gutchen. Unhappily, the skin disease of the steppes (*pruritis scroti*) overtook him, and he was compelled to return from Gutchen. Still, next March, he was again on his way to Lhassa, when the frontier authorities ordered him to postpone his expedition. He then returned to St. Petersburg.

The Lob-nor journey was made in 1877, and although only eleven years have elapsed since, it is almost impossible now to realize the imperfection of our knowledge of Central Asia at that time. When it became known that Prjevalsky had visited the Lob-nor, Baron Richthofen contested the fact, and maintained that the lake which receives the Tarim must be situated further north and due east from the mouth of the Ughen-daria; while now Lob-nor is perfectly well known. As to the natural history collections which were brought in from this second journey, they were even more valuable than those gathered during the first journey. They gave us a clear insight into the flora and fauna of those parts of East Turkestan; while the barometrical measurements enabled us to form, for the first time, a correct idea as to the characters of the Tarim depression of the great Central Asian plateau. It was also from this journey that Prjevalsky brought the wild camel—the ancestor of the domesticated species.

As soon as he was back at St. Petersburg, Prjevalsky hastened to prepare for a new journey; and after having written a short account of his Lob-nor journey, "From Kulja, across the Tian-shan, to Lob-nor," he left the Russian capital for Zaisan, and began his third journey, the most remarkable of all. He soon reached Barkul and Hami, the two Turkestan oases which were almost less known than some parts of the moon. He crossed the Western Gobi, and reached a spot, Dzun-zasak, in South Tsaidam, at the foot of the highlands which separate Mongolia from Tibet. Thence he went south, in order to reach the longed-for Tibetan city of Lhassa. The journey in the highlands which border the great plateau on the northeast was exceedingly difficult. Ridges, 16,000 feet high in their lowest parts (one of them was named after Marco Polo), separated from one another by deep valleys, the bottoms of which are 13,000 and 15,000 feet above the level of the sea, had to be crossed; and when the expedition reached the upper parts of the Blue River, it was brought by the guide to quite impracticable highlands, and had to find its way amid the barren mountains, peopled by Tangutes, whose attacks had to be repulsed by force. Nevertheless, Prjevalsky crossed the highlands, and had already reached, under the 32d degree of latitude, the great valley of the Tibetan river Khara-usu, whence the route to Lhassa was relatively easy; but here a new obstacle rose before him. The Dalai-lama had sent officials who declared to Prjevalsky that the Tibetan nation would not allow Russians to enter the capital of the great chief of the Buddhist religion. The expedition was thus compelled to return; and so it did, recrossing the same highlands in the midst of the winter. Having returned to the Ala-shan town Sinin, Prjevalsky did not like to go back to Russia without having visited the Hoang-ho, which makes a great bend to the north in the neighborhood of Kuku-nor. He reached, in fact, the great river of China at Guidui, crossed it, and explored it for some 200 miles, and only then returned to Kiakhta, after having traveled about 14,700 miles, half of which stretch was surveyed, and bringing in more than 4,500 specimens of mammals, birds, and fishes, 6,000 insects, and many thousands of plants. The most remarkable "find" was, however, the wild horse—the ancestor of our present horse—which inhabited Russia and Poland some two hundred years ago, and has been described by the late I. Polyakoff under the name of *Equus przewalskii* (*Izvestia Russ. Geog. Soc.*, 1881). It is hardly necessary to say that this remarkable journey produced the greatest impression on the scientific world. The Russian Geographical Society elected Prjevalsky an honorary member, the city of St. Petersburg offered him its honorary citizenship, and many scientific bodies bestowed on him all kinds of distinctions. The general results of this journey were embodied in a work entitled "Third Journey to Central Asia," which also has been translated into many European languages.

As soon as the publication of this work was ready, Prjevalsky started again, in November, 1883, on a new journey, again proposing to visit Tibet. This time he started from Kiakhta, crossed the Gobi in the winter, and soon reached the spot, Dzun-zasak, whence he intended to start for the exploration of the highlands of northeastern Tibet. But all kinds of misfortunes attended him. The expedition, freely provided with money, already numbered twenty-one men, and so it could not move with less than fifty camels and several horses. It was found very difficult to obtain such a number of animals from the poverty-stricken populations of South Tsaidam; and Prjevalsky, usually so mild in his relations with the natives, resorted to violence. The animals he thus secured proved to be quite unfit for journeys across the high ridges which fill up the space in the south of Dzunzasak; and it seems most probable that by taking a route due south from that point, instead of proceeding southwestward as he did during his third journey, Prjevalsky committed an error. Not taking into account the northeastern direction of the ridges, he had to cross the numerous ridges of the Upper Hoang-ho, instead of availing himself of the depressions having a southwestern direction, which permitted him to reach the Khara-usu in 1880 without serious difficulty.

It is true, that by taking a southern direction, he reached the two great lakes Jirin and Orin, through which the Upper Hoang-ho flows, and that he thus solved one of the problems of the geography of Asia. But when he went further south, he had to cross such a succession of wild highlands of an Alpine character that his camels were soon disabled; and when he reached the Dy-tchu, or Upper Yang-tse-kiang, some 120 miles to the east of the spot he visited in 1872, he found it impossible either to cross it or to follow the river downward. He was obliged to return, and on his way back he even could not fully explore the lakes Jirin and Orin, because the Tangutes, gathering in hundreds, violently attacked the caravan, and were repulsed only after having lost a great number of their warriors.

Having returned to Dzun-zasak, Prjevalsky went northwestward along the foot of the ridges which separate Mongolia from Tibet, and, when at the lake Gas, he made a winter excursion into the highlands. This excursion enabled him to get a clear idea as to the series of parallel ridges which separate the Tsaidam from the higher terrace of plateaus of Northeastern Tibet. Moreover, instead of returning from Lob-nor by his usual route, he pushed westward into East Turkestan, as far as Khotan, and returned to Russian Turkestan *via* Aksu, thus covering nearly the same ground as that visited at the same time by Mr. Carey.

Years and years will pass before all the specimens of plants and animals brought in from his four journeys can be fully described. Maximowicz's description of Central Asian plants, now being printed by installments in the Bulletin of the Moscow Society of Naturalists, already gives some idea of the richness of Prjevalsky's collections, which represent a total of 700 specimens of mammals, 5,000 of birds, 1,200 of reptiles and amphibia, 800 of fishes, 2,000 mollusks, 10,000 insects, and from 15,000 to 16,000 plants. All the zoological specimens are in the St. Petersburg Academy of Sciences, the botanical specimens at the St. Petersburg Botanical Garden, the geological collections at the St. Petersburg University, and special funds have been granted by the government for the publication of the scientific results of these journeys as soon as the necessary work has been done by the specialists.

The volume embodying the general results of Prjevalsky's fourth journey, and entitled "From Kiakhta to the Sources of the Yellow River, Northern Tibet; and the Journey from Lob-nor through the Basin of the Tarim," reached London only a few weeks ago, and the present writer was preparing an account of it when the sad news reached us from Vyernyi. Although less striking than his previous books, so far as geographical discovery is concerned, this work may be even more important for the light it throws on the nature of a wide, unknown country. It presents also the clearest view of the traveler himself, and affords a clew to the causes of his success.

In a chapter devoted to the ways and means of traveling in Central Asia, Prjevalsky gives detailed instructions as to how an expedition ought to be organized, and when speaking of the traveler himself he writes: "As to the person who will have before him the beautiful task of scientifically exploring new regions, his task will not be easy. The explorer will have to pay for the smallest discoveries by plenty of suffering, physical and moral. He must be strong physically and morally. Flourishing health, strong muscles, and still better an athletic complexion, on the one side, and strong character, energy, and resoluteness on the other—such are the features which best guarantee success." And, after mentioning the necessity of general scientific knowledge, and of special knowledge in, at least, some one branch, as well as the necessity of a real passion for traveling, Prjevalsky adds: "Moreover, he must be an excellent shooter, and, still better, a passionate hunter,

He must not despise any hard manual work, as, for instance, the saddling of horses and camels, the packing of luggage, and so on—in short, he must never be a 'white-handed' person; he must not have habits of luxury; and he must have a pleasant, lenient character, which will soon acquire for him the friendship of his traveling companions." In these sentences he characterized himself. To renounce, if necessary, every comfort; to live the life of the other members of the expedition, without any distinction between the scientific staff and the simplest soldiers or Cossacks; to sleep in the same tent, to eat the same food, and to do the same work as the rest—such were Prjevalsky's rules. We must add also that, especially during his first two journeys, his relations with the natives were of the most friendly character. He carefully avoided any conflict with them; and when it happened once, during his first journey, that the natives were hostile to him, and this hostility might have ended in an armed conflict, he preferred to win their respect by the following stratagem. He and his three men—all four admirable sharpshooters—opened a fire from their breech-loading rifles upon the carcass of a horse, from a great distance. In two minutes they had discharged thirty bullets each, and they advised the Mongols to see if any bullet had touched the carcass. The Mongols rushed, of course, to the carcass, and, to their great astonishment, after hard work with their knives, discovered most of the 120 bullets in it. They did not fail, after this, to treat their visitors properly.

It is impossible to mention Prjevalsky's name without being reminded of his traveling companions. He himself so often expressed his gratitude to them, and he always wrote with so much sympathy about their common experiences, that we shall only be carrying out his wish in stating that Lieut. Pyevtsoff during Prjevalsky's first two journeys, Lieut. Roborovsky in the last two journeys, and M. Kozloff during the fourth, have their full share in what Prjevalsky modestly described as his "scientific reconnoiterings" in Central Asia. Their portraits, as well as his own, are given in his last work.

P. K.

THE SKELETONS OF THE MUSEUM CETACEA.

THERE is some work going on at present at the Jardin des Plantes which, though on a smaller scale, recalls that which is being pursued so actively on the Champ de Mars. It is a question of delivering to the public at large, on the day of the opening of the exposition, the new galleries of natural history designed to receive the collections that have hitherto been scattered through several buildings. The new establishment consists of an immense glazed hall of rectangular form, several stories high, around which run two rows of galleries.

One of the great attractions of this magnificent museum will undoubtedly be the exhibition of the skeletons of six cetaceans. Our engraving represents, in front and side view, the skeleton of one of these gigantic creatures mounted upon a temporary scaffold. The specimen that we figure measures seventy-five feet from head to tail. The carriage of these huge masses of bones and the placing of them in order in the first place was not an easy thing to do, and yet it was the easiest part of the work. It next became a question of building up, piece by piece, the remains of these enormous animals, of raising, one by one, these heavy bones to a height two or three times that of a man, and of holding them in position—something after the manner of a house that is begun at the roof. Continuous work was necessary (it was begun in the month of August), with the aid of numerous preparators, carpenters, locksmiths, workmen, the constant surveillance of the professor, and repeated colloquies with the architect, in order to put the thing through. But, aside from the handling of so bulky pieces, the great difficulty was to give the skeleton the lines and curvature that the animal possessed when living. As may be seen from our figure, the curvature is very marked throughout the entire length of the dorsal vertebræ, whence the ribs start, and afterward bends insensibly in the lumbar region, the form becoming rectilinear in the tail, the extremity of which is at the same height as the end of the nose. Two iron rods, whose flexion had to be calculated in advance, according to these data, support these bony pieces all along,

THE BALD-HEADED CHIMPANZEE.

and hold them in their natural position, while, at the same time, trestles and a complicated scaffolding support the entire weight of the skeleton. But this is merely temporary. It is now for the architect to assure the final construction. Some of the vertebræ have been perforated here and there, and a large iron rod, weighing of itself more than six hundred pounds, will connect them, and, with its head resting upon the vertical rods, will constitute the final support.—*L'Illustration.*

[NATURE.]

THE BALD-HEADED CHIMPANZEE.

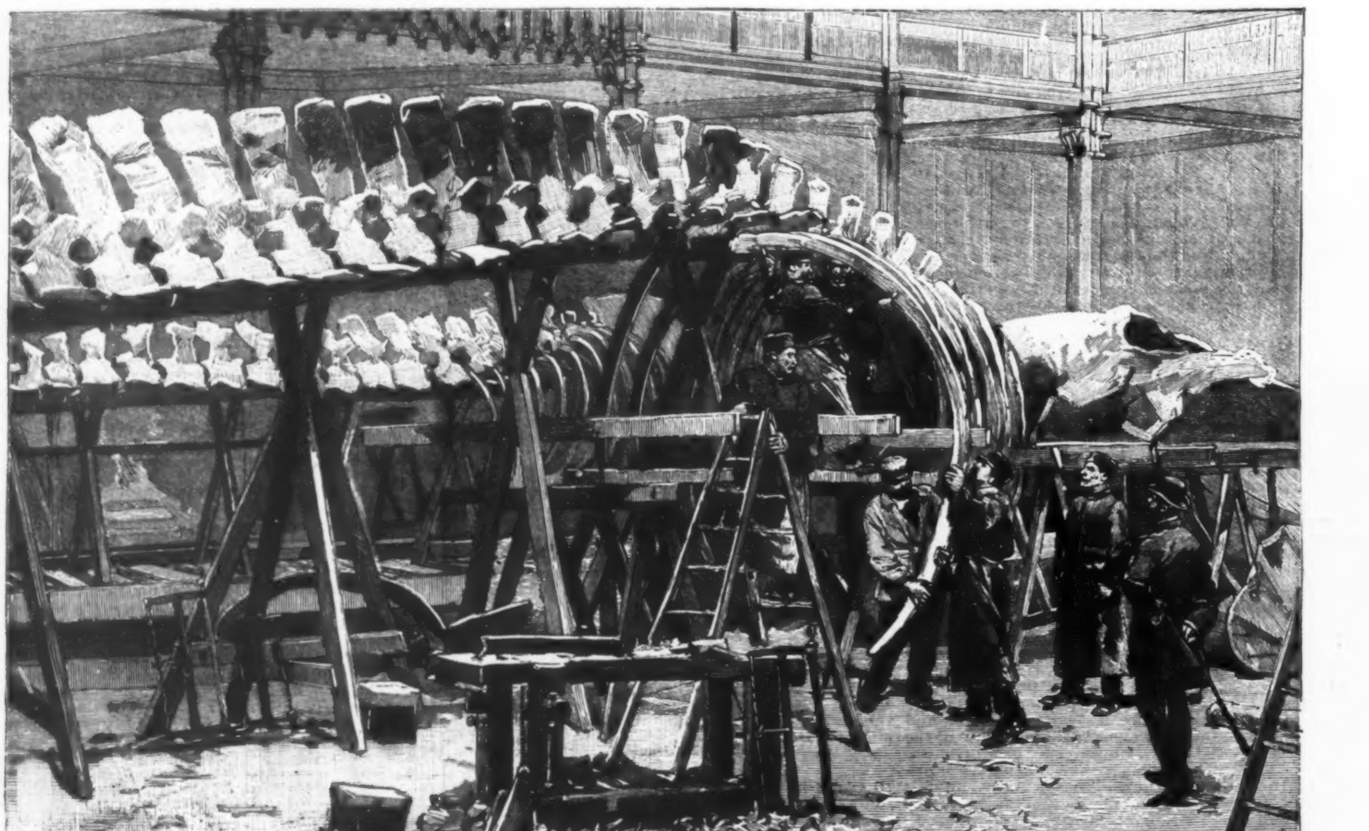
THERE is no longer any room for doubt among naturalists as to the complete distinctness of the larger anthropoid ape of tropical Africa, the gorilla, from its smaller brother, the chimpanzee. The differences are amply sufficient for specific, if not for generic, distinction. But on the question whether there is only one chimpanzee, spread over a great extent of the African continent, or several species confounded under the same name, there is still much difference of opinion. As long ago as 1853, M. Duvernoy communicated to the Academy of Sciences of Paris a short description of a second species of chimpanzee (see *Comptes Rendus*, vol. xxxvi., p. 927), based on specimens obtained by Dr. Franquet in Gaboon in 1851. M. Duvernoy subsequently published an elaborate memoir on the same subject in the *Archives du Museum* (vol. viii., p. 1). The distinctions insisted upon by Duvernoy between his *Troglodytes tschego* and the ordinary *T. niger* were chiefly osteological; at the same time he characterized the *tschego* (from M. Franquet's description) as having the "face black and the ears small," while, according to the same authority, the ordinary chimpanzee has "very large ears, and its face flesh-colored."

In 1858, in a memoir also published in the *Archives du Museum* (vol. x., p. 94), on the specimens of anthropoid apes in the Paris collection, M. Isidore Geoffroy St. Hilaire published a letter from Dr. Franquet in which the latter again insisted on the differences of the three species of anthropoid apes observed by him in the district of Gaboon. These were characterized as follows:

1. The *Chimpanzee*, with the face flesh-colored, the ears red and large, and the fur black.
2. The *Gorilla*, with the face black, the ears small and black, and the fur of a brownish chestnut, but varying in tint in different parts of the body, and with always a row of reddish hair starting from the middle of the forehead and following the line of the sagittal suture.
3. The *N'tchego*, with the face black and the ears small, as in the gorilla. The hairs of this ape, he says, are shorter and darker in color, and it never attains the size of the gorilla, or carries the red crest across the forehead.

In 1860, the well-known traveler Mr. P. B. Du Chaillu gave his account of the anthropoid apes of the Gaboon to the Boston Society of Natural History (see Proceedings of that Society, vol. vii., p. 296). Mr. Du Chaillu described, as a new species of chimpanzee, *Troglodytes calvus*, "with the head entirely bald to the level of the middle of the ears behind," and "having large ears," while he identified the *N'tchego* of Dr. Franquet as being nothing but the adult chimpanzee (*T. niger*). In a second communication to the same society (*op. cit.* p. 358), he described another new species of chimpanzee, with a black face, but the forehead not bald, which he called *Troglodytes kooloo-kamba*, from its peculiar cry.

In 1861, the late Dr. J. E. Gray examined Mr. Du Chaillu's specimens of apes, and came to the conclusion that both his supposed new species were only varieties of the common chimpanzee (see P. Z. S., 1861, p. 273). Such also, as was stated by Dr. Gray, was my own opinion at that time, and I have remained in a doubtful state of mind on the subject until a recent period. But the acquisition of the fine female specimen of chimpanzee, generally known by the name of "Sally," by the Zoological Society in 1883, caused me to change my views very materially. There can be no doubt that this animal, when compared with specimens of the ordinary chimpanzee, presents very essential points of distinction. The uniform black face and nearly naked forehead, which is only covered with very short black hairs, together with the large size of the ears, render "Sally" conspicuously different from the many specimens of the common chimpanzee (at least thirty in number) that the Society has previously received. I was at first inclined to believe that "Sally" might be referable to the *Troglodytes tschego* of Duvernoy. But nothing is said, in M. Duvernoy's description, of the bald forehead, and the small ears attributed to the *N'tchego* are directly contrary to this hypothesis, as in "Sally" these organs are exceedingly large and prominent. On the whole, I was inclined to believe that "Sally" might belong to the *Troglodytes calvus* of Du



MOUNTING A WHALE'S SKELETON—JARDIN DES PLANTES, PARIS.

Chaillu, and she was accordingly entered in the register of the Society's menagerie as the Bald-headed Chimpanzee (*Anthropopithecus calvus**), which is certainly a very appropriate name, even if it be not technically correct.

In the beginning of the present month we purchased of Mr. Cross, of Liverpool (from whom we had also obtained "Sally"), a second specimen of the bald-headed chimpanzee, likewise a female, which, although much smaller in size, closely resembles "Sally" in every other respect.

Fortunately, there is now in the Gardens a young specimen of the common chimpanzee (*Anthropopithecus troglodytes*), presented to the Society in May last by Mr. F. J. Aldridge, F.Z.S., by whom it was brought from Sierra Leone. This specimen is of about the same size and age as the young bald-headed chimpanzee, and enables an easy comparison to be made between the two species. Looking first at *A. calvus*, we find the skin of the head, face, ears, and limbs of a dark brownish clay color, which will, no doubt, get blacker as the animal becomes adult. The ears are perfectly naked, and of large size, and stand out at nearly right angles from the head. The top of the head is very scantily covered with short blackish hair. The whole of the body and limbs are also very thinly covered with hair, especially the abdomen.

When we turn to the young specimen of *A. troglodytes*, we find the upper part of the face and the brows of a dirty flesh color. Between the eyes, above the nostrils, and passing down the cheeks, it is black. The nose and muzzle are of a dirty flesh color. The chin and upper lip are covered with longish white hair. The inside of the ears is nearly black. The forehead, cheeks, and the whole of the body are covered with long, harsh, black hair. The color of the hands and feet are of a brownish clay color, much the same as those of *A. calvus*. The rump, above and below the anus, is covered with longish white hair.

With regard to the size of these two animals, the length of limbs, and other measurements, they are nearly equal. It is probable that *A. troglodytes* is a trifle older than the new specimen of *A. calvus*.

It may be of interest to mention that, as Mr. Bartlett informs me, the young *A. calvus* will kill and eat sparrows in the same manner as "Sally" kills and eats pigeons, whereas the common chimpanzee will not touch any food of this kind.

It must be admitted, however, that the specific term *calvus*, applied to "Sally" and her "younger sister," can only be considered as provisional. When these specimens die, which, we trust, will not be till some distant period, they must be compared with the example of the *Troglodytes calvus* of Du Chaillu which is now in the British Museum. On the same occasion the skulls of these specimens can be compared with the descriptions and figures given by Duvernoy of his *Troglodytes tschego*. Until this can be done, it is impossible to say decisively whether these two specimens belong to one of the supposed species already described or should receive a new name.

Finally, I may add that the ape house in the Society's gardens, besides these two chimpanzees, contains at the present time a young female orang (*Simia satyrus*), received on deposit, and a specimen of the silvery gibbon (*Hylobates leuciscus*), lately presented by Captain D. L. Delacherois; so that all the three known genera of anthropoid apes may be now seen represented by living specimens. P. L. S.

FLAX CULTURE.

By H. Monie, Jr.

Hackling.—This word can be used either as a term for a particular process or as a general term for a combination of processes. In a particular sense it is applied to what is known as "machining," and in a general term it includes "roughing," "machining," and "sorting." The object of the process is to thoroughly separate the fibers from any straw which may still be adhering to them. If we examine a handful of material after it has come from the scutcher, we may find particles of shell attached, which give a somewhat matted appearance to it, and instead of every filament being entirely free from its neighbor, many of them are still attached together. Hence the necessity for submitting the material to a combing operation, in order to thoroughly remove all impurities and perfectly free the fibers from one another. The first of the processes which come under this heading is termed

Roughing.—The flax fiber when it reaches the spinning mill is taken and usually weighed into lots of two cwt. each, which are then given to the men engaged in the "roughing" process. Each man has a certain stand allotted to him at a table or bench, which runs along both sides of a room, similar to the arrangement shown in Fig. 1. On the shelf at his left hand side is deposited his supply of material, and from this he removes a handful of the filaments, which he makes even at the ends. On the table before him lies a block set with several rows of steel pins about six inches in length, and through these he rapidly draws the material several times.

In this way the coarser of the impurities are combed out, and also some of the inferior fibers, the latter of which is preserved in the waste room to be disposed of as "roughing tow." When each handful of the material has thus been fully operated upon, the "rougher" gives it a slight twist, so as to keep each "piece," as they are now termed, separate. Preparatory, however, to doing so, he makes the fibers of an equal length by breaking or cutting off the longer portions on an upright steel pin called a "touch pin." The fibers which now compose the piece are termed "long line," and are then either hackled by hand or by machine, the process being called in the latter case

Machining.—In the spinning mills of Ireland at the present time there are several forms of hackling machines in use, although the principles embodied in their several constructions are in many respects similar. To clean the long line thoroughly, and remove all imperfect and short fiber with as much speed, perfection, and economy as possible, is the great aim of the process, and the one kept in view by all machine makers. The general system on which the operation is conducted is as follows: The pieces which were kept separate from one another by the twist given to them by the rougher are taken and their ends placed between the serrated faces of two small iron plates, which are then screwed securely together by a bolt and nut through their centers. These holders are then placed on their edges in a horizontal groove or channel running along the machine above the hackle needles, which revolve on two parallel rollers working into each other. From the channel overhead the flax is, of course, pendent, and hangs between the cylinder needles, so that these pierce it from both sides, and when revolving comb all impurities from the fibers, and leave them straight and parallel. While this is being done the holder is being moved along the channel on a traversing arrangement toward the other end of the machine, and at the same time, by means of cams and connecting rods, the channel alternately rises and falls toward the hackles, so that the flax from the edge of the holder downward is fully operated upon. The hackle needles vary in the number per inch at different parts of the machine, the coarsest coming into contact with the material first, and the finest when the end of the traverse has been reached. The holders are then removed, unscrewed, and the flax reversed in them, when they are again passed into operation by being placed in another channel of the same machine, the traverse of which works in the opposite direction, so that they are returned to the end from which they started.

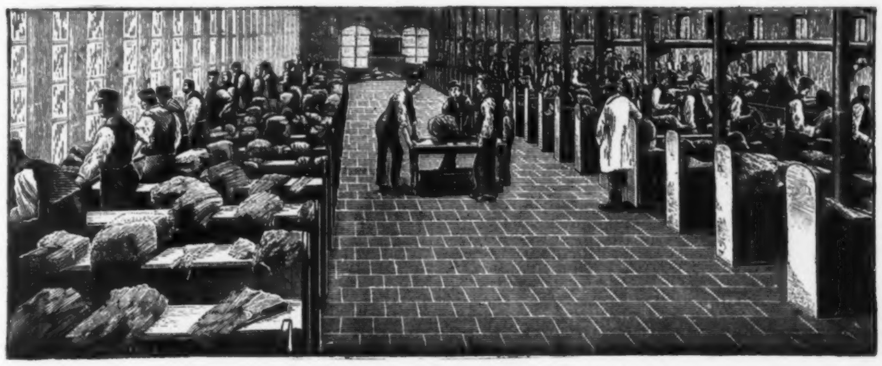


Fig. 1.—SORTING DEPARTMENT IN SION MILLS.

This, then, is the general system on which machine hackling is conducted, and is applicable to all makes of machines, no matter how much they may vary in detail, so that for the present article this description will be sufficient. Underneath the hackles three boxes or baskets are usually placed, which occupy the whole available space under the machines. These are for the reception of the tow which is combed out in the process, the first receiving the coarsest of the combings, and the last the cleanest and finest. When the operation is completed, the machined flax is taken from the holders and placed in a box, piece upon piece transversely, so as to prevent the pieces from mingling, and thereby avoid the necessity of again singling out the handfuls at the next process. Each parcel of long line is now termed a "tipple," and is then removed to the next room to undergo the operation of

Sorting.—Our illustration, Fig. 1, gives a clear and comprehensive view of the large sorting department in Sion Mills, County Tyrone, and of the manner in which the sorters' boxes are distributed along both sides of the room. The process is entirely one of manual labor, and those to whom it is intrusted should be men of wide experience among all classes of flax, otherwise much loss and injury to the material will be the result. The sorter's duty is a twofold one, he being required to comb the fibers in exactly the same manner as described under "roughing," the only difference being that more care is required, as the steel pins in the blocks are very much finer and greater in number. He must also with his hands separate the fibers from each piece, placing each quality by itself, and ticketing it for the spinning of a certain number of yarn. In all flax deliveries, and even in the product of the same acre, considerable variation exists in the fibers, some being finer, longer, clearer, or stronger than others, and therefore better adapted for the spinning of finer or stronger yarns, as the case may be. It therefore becomes necessary to separate the various qualities and ticket them in the order of their capacities, and as this cannot possibly be done by machinery, experienced men have to be employed for the purpose. The sorter's duties, it will thus be seen, are of a responsible nature, and exert great influence on the quality of the product. When this operation has been completed, the material is then termed "dressed line," and is removed to the preparation machinery, or if not then required, to the line store, care being taken to keep each division by itself.

In Irish flax mills, one object of importance in conducting the processes of roughing, machining, and sorting is to be able to determine the loss in waste at each, so that the cost of the work at every operation can be seen at a glance by the manager or directors. The manner in which this is accomplished is as follows: When the 2 cwt. of material has been roughed, the tow made in the operation is weighed, and this, added to 1 lb., which is allowed for waste, is deducted, and marked on a ticket given to the rougher, on which is also written his name and number. The same system is gone through at the machining, the weight of the tow in each of the three boxes being marked on the ticket, and also that made at sorting, added to a pound or two allowed for waste. Each ticket as it is thus filled up is handed into the line office, and is then copied into a book kept for the purpose. The loss for each lot can in this way be seen at once, and when all the tickets representing a purchase or delivery of flax have been handed in, the items are added up, and the total weight compared to that on the invoice of the purchase. The various tows are then marked at their current value, the total being then deducted from the original cost, plus the cost of hackling. The total pounds of dressed line shown in the book are then divided into the remaining sum, which, of course, gives the average cost per lb. of the line. From this the cost of the different sorts are proportioned.

Spreading.—Up to this point in the process of the linen manufacture, the work has been intrusted entirely to male operatives; but in this and all the succeeding operations, female labor is almost exclusively employed. The machines, also, which are yet to be described are, without exception, self-acting, whereas much of the work to which we have already referred requires to be done by hand. Spreading frames are the first machines that are used for converting the various lots of dressed line into a continuous end, or, as it is technically termed, "sliver." At the back end of the frame several endless leather belts or aprons (generally either four or six) are caused to traverse slowly over a flat surface, motion being conveyed to them by passing them round two revolving rollers. On these belts, and parallel to the direction of motion, the line is carefully laid down, the lots being so placed as to allow of their ends overlapping each other. The thickness of material which should be thus spread is determined by the class of yarns to be spun—the coarser the numbers, the greater being the quantity required for the purpose. The usual method now adopted for the

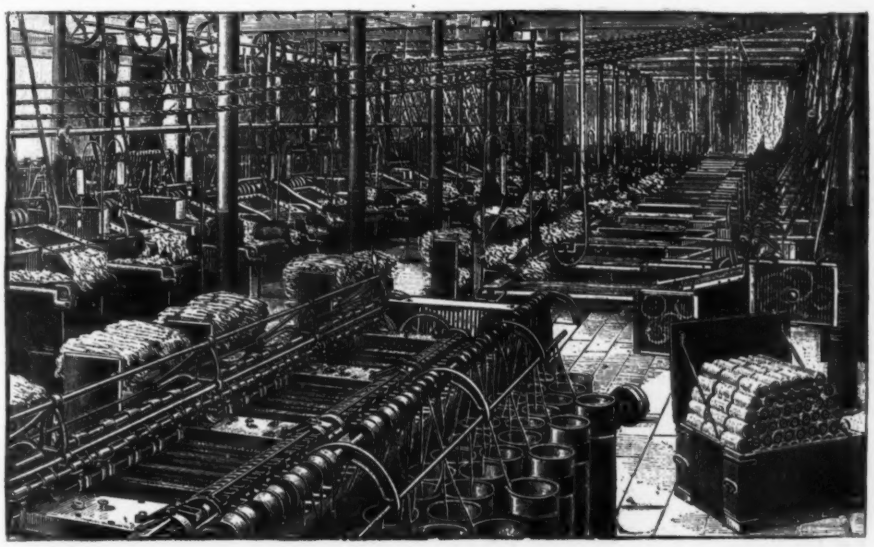


Fig. 2.—SPREADING MACHINES.

FLAX CULTURE AND THE IRISH LINEN TRADE.

* The term *Troglodytes* being more properly used for a genus of birds, it becomes necessary to employ for the chimpanzees the generic term "*Anthropopithecus*," of Blainville, as suggested by Peters in 1876.

attainment of this object is to have small scales placed at different parts throughout the room on which to weigh out the flax in quantities as may be required. When this has been done the lots are then removed by boys and deposited into separate boxes convenient to the machines, from which the spreader again takes out the handfuls as made up by the sorters, and arranges them on the feed board. Where fine yarns are spun, each handful before being spread is separated into two equal portions by the operator, which, of course, reduces the thickness of the layer by one-half. Without some such system as this one may easily imagine how irregular in weight and thickness the delivered sliver would be throughout its length, and the tendency that would exist toward producing uneven and variable yarn. Where more than one quality of flax fiber is to be used in the production of the same yarn (as is often the case), the receiving boxes at each machine contain the distinctive qualities, and from these alternately the attendant takes the material for the spread. Sometimes this blending is done by the doubling process alone, each belt being covered with a separate quality or variety. Leather travelers, in a horizontal plane, now conduct the flax forward to the end of their traverse, where it is removed by little narrow strips filled with needles termed "gills." These are sharply pushed upward from underneath, and entering between the fiber carry the material forward on a slight incline toward a pair of delivery rollers. The gills are actuated by two screws, one being of a finer pitch than the other, and cut in an opposite way, and travel along the finer screw at the same speed as the feed. When, however, the material has passed to the rollers they drop down into contact with the coarser screw, and are returned at a much greater rate of speed to the other end, where they are again raised to the starting point. The front rollers are of different characters, the bottom one being of iron and extending across the machine, while there is a top one for each end or sliver. These are made of hard wood, and firmly pressed to the bottom roller by means of hand screws, from the contact of which they derive their motion. This prevents any possibility of the material slipping while passing through between them, and so keeps the draught perfectly uniform at every point. The circumferential velocity of these rollers being much greater than that of the gills, the fibers are drawn out to their limit of elasticity, and the ends become elongated and reduced in thickness and weight. This "draught," as it is termed, can be regulated to any degree required by means of change pinions in connection with the rollers. The material, by now passing through a trumpet mouth or small funnel, is delivered in the form of a thick ribbon or sliver, and is in this condition transmitted to a can in front of the machine, which when full is called a "set can." In a spreading machine with either four or six leather travelers, the spreads are, for the production of medium yarns, combined and run into two ends, and for fine yarns into one end. This doubling of course tends to nullify the effect of the irregularities which must necessarily accompany spreading by hand. In order to have the cans at the various machines filled with approximately the same weight of material, there is an arrangement of gearing on the delivery roller end, to which is attached a hammer adapted to ring a bell whenever 1,000 yards have been delivered. The sliver is then broken off by the attendant, the can removed and replaced by another, until a set has been made up, which consists of either six or twelve, and these are then placed at the back of the first machine in the next process. For each spreading machine two attendants are employed, one on each side, their sole duty being to keep the frame supplied with material. They never require to leave their post, as the flax is brought to them by boys, and the cans removed when full, to be weighed by employes for the purpose. Fig. 2 gives an illustration of the spreading machines, and shows the manner in which the bundles of flax are arranged.—*Industries.*

THE SWEET POTATO.

THE sweet potato has many strongly marked and permanent varieties, but when one hears or reads of them by name, he cannot at all feel certain of what he is hearing or reading about, owing to there being no settled nomenclature for the different varieties of the product. In traveling over the Southern States you will find the same variety sailing under a different name in almost every settlement, usually going by the name of the man who first introduced it there, or the name given by him, or that of the man who is making a specialty of it. For instance, we have a pale red variety known here as the Musgrove, there as the Dooley, at the other place as the Hayti Yam, and in still another place as the Red Bermuda, and so on. Under such circumstances, it would be impossible to order the variety from a distance with any certainty of getting what one wanted. I have often urged the people interested in sweet potato culture to hold a convention for the purpose of establishing a regular sweet potato nomenclature. I think the existing inconveniences, as just hinted at, certainly demand it. Nothing we cultivate on so large a scale as we do the sweet potato in the South lies under such perplexing uncertainty as to names of established varieties.

The sweet potato is one of the very important products of the country lying along the Gulf of Mexico east of the Mississippi River, and along the lower Atlantic further east. It is the easiest crop to raise that the Southern people grow. The yield is enormous. With comparatively little attention, it gives us a yield of from 200 to 400 bushels to the acre, and the trouble of keeping it over to the next season is scarcely worthy of mention. We throw the potatoes up in heaps of 15 or 20 bushels, in the open ground, place over the heaps a few inches of straw (usually pine straw), and over the straw a few inches of earth, and the work is done. They will be found as sound and good there next May as when they were first "banked," as we call it.

To-day (November 27) the people of the Gulf coast region are busily digging their sweet potatoes. The yield for the season is very good, as a rule. There has been no frost to touch the vines up to this date, consequently the patches are regular flower gardens, so to speak. To the Northern sweet potato grower, who is not thoroughly informed relative to the peculiarities of the crop down here, this mention of flowers will be something of a surprise. The sweet potato is a heavy bloomer with us, beginning to show its flowers about the last of July, continuing till frost. The flowers are of a pale blue color, and much resemble those of the small-flowered morning glories. In some seasons the flowering is heavier than in others; the present has been one of those heavy flowering seasons. So numerous are the flowers on the vines of a patch now in sight from my window, that the entire surface of the growth presents a bluish shade. Freely as it flowers in this region, the sweet potato does not appear to mature any seed. I have never yet been able to find a single perfect seed pod.—*J. P. Stelle, in Rural New-Yorker.*

IRON IN BURMAH.

DR. NORTLING, of the Geological Survey of India, in a recent report on magnetic rock among the Shan Hills of Upper Burmah, describes a mountain or hill at Singaung which "consists of a huge mass of iron ore." Having, he says, noticed on the way numerous pieces of iron ore, which became more frequent on the southern side of the hill, he examined the latter in several directions. He found the surface everywhere covered with large blocks of iron ore, originating evidently from superficial decomposition of lower beds. He concluded that the whole hill consisted of a huge mass of iron ore. He was unable to ascertain the geological conditions under which this ore occurs, or its exact limits and extension, on account of the dense jungle and the tremendous attraction, rendering his compass useless. He estimates, however, that the hill covers at least an area of about a square mile, and that it rises about 200 feet above the level of the Twiunge valley. The ore is hematite, peroxide of iron.

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